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THE HUMAN BRAIN:

ITS

STRUCTURE, PHYSIOLOGY AND DISEASES.

WITH A

DESCRIPTION OF THE TYPICAL FORMS OF BRAIN IN THE ANIMAL KINGDOM.

BY SAMUEL SOLLY, F.R.S.,

SENIOR ASSISTANT-SURGEON TO ST. THOMAS'S HOSPITAL, AND LECTURER ON CLINICAL SURGERY, ETC. ETC.

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TO

BENJAMIN TRAVERS, Esq., F.R.S.,

PRESIDENT OF THE ROYAL COLLEGE OF SURGEONS OF ENGLAND,

IN REMEMBRANCE OF MANY KINDNESSES,

AND AS A TRIBUTE OF RESPECT

FOR HIS DISTINGUISHED TALENTS,

THIS WORK

IS INSCRIBED BY HIS OBLIGED PUPIL,

AND SINCERE FRIEND,

SAMUEL SOLLY.

PREFACE.

In the first edition of this work, in 1836, I remarked that the structure and functions of the human brain are objects of comparatively slight interest to the medical student. I fear that this is still too much the case in 1847.

According to the plan generally pursued in describing the brain, in systematic works of anatomy, the information conveyed amounts to little more than a vain catalogue of names applied to parts, without reference to their structure, their functions, or even their analogies in the nervous system of the lower orders of animals. Such a barren prospect as a list of names holds out but little to attract the most zealous among students, while the dryness of unconnected detail, and the obstacles to clear conceptions engendered by the absence of everything like arrangement, almost certainly deter him from attempting to learn more than is required to prepare him for examination for the diploma. It is unfortunate, indeed, that candidates for this honorable certificate are still very generally required to describe the appearances presented by the brain dissected, or rather destroyed, by the old method of slicing; a method most unphilosophical in its conception, and totally inadequate to impart any real information in regard to the structure of the organ. And I do not hesitate to affirm that this mode of examination has contributed essentially to retard the diffusion of sound knowledge in regard to the anatomy and physiology of the most important system in the body.

It is sad to reflect that medical students, on whom the duty devolves of tracing the relations which exist between the structure of organs and their functional manifestations, with a view to the successful treatment of disease, should thus neglect the most important part of the whole

organism. No labor should be thought too great which can assist us in understanding the nature of that instrument which the mind employs in its communications with this world. Every day shows us that consciousness and volition may be disturbed by the slightest accident to the head, and that disease seldom invades the brain without dethroning the mental powers.

When I published the first edition of this work, I was not aware that so high an authority as Dr. Craigie had exposed, in the following forcible language, the evils I then, and have since, deplored. I gladly avail myself of his authority to assist in subduing this evil:—

"To the mind, however, which is unfettered by prejudices in favor of ancient opinions, it appears singular that the enlightened physiologists of the eighteenth century should talk of the medullary and cortical matter of an organ in which nothing like marrow or bark can be seen; and it is more extraordinary still, that the accurate distinctions which anatomy has introduced since the commencement of the nineteenth century, have not demonstrated the evil of retaining terms which are improper, as mere nominal distinctions; but which are doubly erroneous as the relics of an unfounded and exploded theory. Is the error of likening the brain to marrow, obviated by shrouding it under the learned denomination of medulla and medullary? Or is the absurdity of supposing the gray matter of the convoluted surface, a bark, or envelope to the white pith, diminished in the slightest degree by calling that gray matter cortical? The common sense of the present day will not hesitate to answer these questions in the negative.

"Should it be said by the ambiguists, that now, when the absurdity of these names is known, it can do no harm to retain them as mere names, we answer, it may do no harm; but as it can communicate no information and explain no difficulties, it is, at least, a superfluous labor to augment the confusion of a department of anatomy not very easy, by useless and antiquated names, which live only to proclaim their absurdity, and the impropriety of finding them there. Knowledge, in the present day, to be worth the labor of acquisition, ought to be accurate; the books which are to be the means of conveying this knowledge ought to contain no superfluous or erroneous information."

Foville, who has devoted so much attention to the structure of the

brain, though he has paid too little attention to the labor of others, thus expresses himself in regard to the difficulties which attend its study:[*]—"If we confine ourselves to the examination of its exterior, we know no more of its organization than we could know of the human body if we merely looked at the surface of the carcass: even sections of the brain teach little more than sections of the body would."

Foville gives to Gall the credit of teaching us how to separate the fibres of the brain without *cutting* them.

I have been much disappointed with Foville's work. The anatomical descriptions are most tediously minute, without any reference to physiological inferences. For instance, the shape and outline of a part will be given most accurately, but not one word regarding the course and direction and termination of its component fibres; and still less is any attempt made to classify the component parts of the brain under the heads of ganglia, commissures and nerves. So that, after having waded through a long description, the pons Varolii, for instance, we are left quite in the dark as to whether this part is a commissure or a ganglion, or both combined.

Is it not strange that any man who has devoted his attention to the anatomy of the brain, as Foville has done, should gravely assert that we might as well describe the optic nerve as an optic bulb, as the olfactory? No student who has traced the varied forms and position of the olfactory ganglion in the various classes of animals up to man, will make such a mistake. His words are, p. 508: "And if we ought, in speaking of the word olfactory lobe, to separate its description from that of the nervous cords, we ought with equal reason to separate the optic nerve, and present it also as a particular lobe."

Cuvier, in the report which he made to the Académie Royale des Sciences de Paris, upon M. Serres' work, "De l'Anatomie Comparée du Cerveau," remarked very forcibly on the inconvenience of dissecting the brain from above downwards in the manner generally pursued, and he showed that, in consequence of comparative anatomists adopting this mode of dissection, their researches into the constitution of the nervous

[*] Traité Complet de l'Anatomie, de la Physiologie et de la Pathologie du Système Nerveau Cerebro-spinal, par M. Foville, p. 41.

system of the lower orders were productive of very imperfect results, inasmuch as the chain of resemblance between the lower and the higher orders of animals was soon lost sight of; whilst M. Serres, by commencing with the dissection of the spinal cord, and tracing it upwards, was enabled to throw great light on this interesting branch of physiology, and to prove that there is a regular gradation in these parts, that the chain is perfect, and that such differences as do occur simply consist in the abstraction of parts, and the loss of those powers which have been proved to be dependent on them.

With regard to the nomenclature which I adopted in the first edition, I shall continue to adhere to it in most instances, as I believe it to be simple and correct. I still think it is an error not to distinguish the ganglionic portion of the hemispheres from the rest of the mass, as the *hemispherical ganglion*, but I would willingly have adopted a different title if a better one had been proposed.

I have endeavored, without presuming to arrogate to myself the credit of discovering any new system, to lay down a plan for the study of the anatomy of the cerebro-spinal axis, founded upon the rational basis of investigating its structure in man by the light of comparative anatomy.

The only philosophical method of simplifying and giving a character of general interest to the anatomy of the human brain, is by commencing with the structure and functions of a nervous system in the lowest and simplest forms of animal existence, rising by degrees to the highest, carefully observing each addition of parts, and the relationship borne by these to an addition of function. By pursuing this course we shall be rewarded by finding that the encephalon, this apparently most complicated organ in the human being, is but a gradual development from an extremely simple fundamental type on one uniform and harmonious plan, and that the seeming complexity of the cerebro-spinal axis in man really arises from the great concentration, as opposed to the extreme diffusion, of its component parts in the lower order of animals; for in no particular are the higher orders more strikingly distinguished from the lower than in the concentration of function within circumscribed spaces. In following out the plan I have adopted in this work, I shall strive to avoid, on the one hand, falling into the error of attempting too minute a detail of all the various discoveries which have been made, and giving

an account of all the various opinions which have been broached; and, on the other, of basing my descriptions or confining my views to the circle of my own individual researches and speculations. My constant object will be to clear the path of all unnecessary incumbrances; and, carefully arranging whatever is known upon the anatomy and physiology of the human brain, to keep in view the principle which Herschel has so concisely stated, that "Science is the knowledge of many, orderly and methodically arranged and digested, so as to be attainable by one."

Every honest and erudite anatomist must acknowledge that we are indebted mainly to Gall and Spurzheim for the improvements which have been made in our mode of studying the brain. For my own part, I most cheerfully acknowledge, that the interest which I derived from the lectures of Dr. Spurzheim at St. Thomas's Hospital, about the years 1822 and 1823, has been the inciting cause of all the labor which for above twenty years I have at intervals devoted to this subject. I believe that to Mr. Green, in his Dissector's Manual, is due the honor of having first given to the English student an abstract of Gall and Spurzheim's method of dissecting the brain. Mr. South, in his edition, enlarged it considerably. Believing that, in the first edition of this work, I had unintentionally neglected to do Gall and Spurzheim full justice, I got my friend Mr. Streeter, of Harpur-street, who is well acquainted with this subject, to give me a short historical account of the order in which their labors appeared before the world.

20, Harpur street, April 1847.

My Dear Sir,—As you manifested, in the Preface to the first edition of your work on the Anatomy of the Brain, what Gall, in one of the latest of his written paragraphs, termed "une tendance singulière que manifestent beaucoup de personnes, d'attribuer nôtres découvertes à d'autres, par exemple à Reil," &c., I venture to direct your attention to this error, into which you have fallen, in common with most of the English writers on the anatomy and physiology of this most curious and difficult part of the human frame. I am the more induced to do so, because Dr. Spurzheim himself directed my attention to this error when Mr. Herbert Mayo was engaged in his courses of Lectures on the Nervous System, at the Royal College of Surgeons, nearly twenty years ago, and fell into the same mistake. What Gall has written in its refutation, may be found in the 8vo. edition of his work "Sur les Fonctions du Cerveau," vol. vi. p. 490. What Spurzheim, in a pamphlet, entitled "Examination of the Objections made in Britain against the Doctrines of Gall and Spurzheim," Edinburgh, 1817, p. 50–54; in the Preface to his "Anatomy of the Brain," 1826; and in his reprint of Chenevix's article on Phrenology, from the Foreign Quarterly Review, 1830, Appendix. I would, however, direct your attention to the earliest notices of the dis-

coveries and proceedings of these illustrious men in the English medical periodicals—publications which, as they were not so numerous as in our day, may be fairly imagined not to have been entirely overlooked by the co-existing generation of men.

The earliest notice that I am aware of, that appeared in this country, was that in the Medical and Physical Journal, for 1800 (vol. iv. p. 50). It refers, however, exclusively to craniological ideas:—

"Mr. F. J. Gall, at Vienna, has finished a most elaborate work on the Exercise of the Brain, and on the possibility of recognizing the several Faculties and Propensities from the Construction and Form of the Head and Skull. Mr. Geisweiler, of Parliament-street, has in his possession a part of the manuscript and several drawings, finished in the most curious and elegant style, deserving the attention of the curious. The author intends to publish the work at the same time, both in England and Germany."

This, you will observe, is before Dr. Spurzheim was associated with him. The next medical notice appears in the October number of that Journal for 1805 (vol. xiv. p. 327). The contributor, Dr. Arneman, one of their editors, speaks of Dr. Gall as one "that may justly be ranked amongst the most extraordinary men of the present age." He states that their Prussian Majesties, the physicians of the court, all the medical professors, and among them the Nestor of the present anatomists, Dr. Walter, and almost everybody who makes a claim to a liberal education, attended Dr. Gall's Lectures. He divides the doctrine into two parts—1st, The Doctrine of the Brain; 2dly, The Doctrine of the Skull—and gives an abstract of both. In the March number for 1806 (vol. xv. p. 201), there is another notice, which states that the craniology of Dr. Gall was the favorite topic of the German literati, during the summer of 1805, at almost every university and capital of the Northern provinces of Germany; that Gall employed himself in researches on the conformation and anatomy of the human brain. The government of Vienna, however, forbade his lectures. "But this did not stop his inquiries; students in physic and men of research came from every part to procure information, which he never refused, and his doctrine was soon spread all over Germany by the writings of some of his pupils. The Doctor himself prepared a work, illustrated with copper-plates, in which all his striking observations on comparative anatomy and the dissection of the brain were to be laid before the public. Subscriptions for it were opened, and completed in a short time. But previous to its publication, the Doctor resolved to make a circuit of all the Northern universities and capitals of Germany, in order that the literati and professors might hear and scrutinize the lectures which he intended to deliver in every place wherein he should make any residence."

In the July number of the Edinburgh Medical and Surgical Journal for 1806, will be found a very careful but concise abstract of Gall's Examination of the Brain, abstracted from all the psychical views of its author, from the pen of Professor Rosenmuller of Leipsic. In the same number, there is also a review of Professor Bischoff and Hufeland's Account of Dr. Gall's Cranioscopy, which was looked upon as a correct epitome of Gall's Lectures, and of the objections raised against his demonstrations of the brain, and opinions, by Professor Walter and others. Copies of the abstract by Rosenmuller, and of the review of Bischoff, I enclose, but shall be glad to have them returned at your convenience. Other notices exist in the general periodicals of the day, but these are sufficient to show that Gall and Spurzheim's public dissections and demonstrations of the brain preceded those of Reil in Germany; and it is curious to observe the influence they exerted in leading Reil to publish on this subject in 1807; Baron Cuvier, in France, in 1809; and Sir Charles Bell, whose

first pamphlet was circulated only among private friends, and entitled, "Idea of a New Anatomy of the Brain." The labors of these eminent men, and their successors, have indeed only been successful in carrying out the details of Gall and Spurzheim's general principle, that the nervous system was not a unit, but an aggregation of systems, as numerous as the functions, intellectual, emotional or physical, of which it is the organized instrument.

Believe me to remain, yours, very truly,

S. Solly, Esq. J. S. Streeter.

There is one point regarding the physiology of the brain to which I must here advert. It is Dr. Wigan's theory of the duality of the mind. The facts and reasoning he has brought to bear on the subject are most interesting, and his arguments are well worthy of attention. But to do it justice, and at the same time to criticise it judiciously, would have occupied more space than I could allot to the subject.

I have but few words to say regarding the pathological section. I added it, because I believed it would render the work more useful, and I hope it may prove so, notwithstanding the narrow limits to which I have been obliged to confine it.

With regard to the Wood-cuts, I can vouch for their general accuracy: they are all, unless stated to the contrary, from drawings of my own, or made under my immediate inspection. Some of them I drew on the wood. To Mr. Kearney the artist, and Mr. Branston the engraver, my thanks are due for the trouble they have taken to execute them in accordance with my wishes.

1, St. Helen's Place,
Aug. 25th, 1847.

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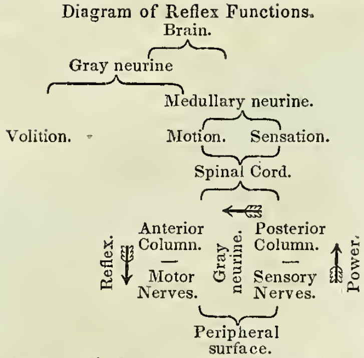


The perpendicular arrows may represent the fibres of reinforcement. The horizontal arrow may represent the transverse commissural fibres of the cord.

THE

HUMAN BRAIN.

PART I.

STRUCTURAL ANATOMY.

Before we commence our study of the configuration and anatomical arrangement of the human brain, we must investigate the physical, chemical, and microscopical character of its component matter. The name of this matter is neurine. Neurine is the substance in which the peculiar powers of the brain and nerves reside. It is never found by itself, for it is too delicate in texture to retain its properties if it were unsupported. It is always supported and protected by the membranous fibre arranged in various ways.

In the construction of the nervous system, the plan is the same as that which prevails in all the other systems of an organized being. Membranous matter forms the basis of each organ, in the interstices of which the peculiar material of the organ is deposited. The bones consist of a membranous network, in the interstices of which the earthy matter is deposited, giving them the solidity required for the performance of their office.

Muscles consist of a membranous network, in the tubular meshes of which fibrinous matter is placed, which is endowed with the power of contraction, on the application of its appropriate stimulus. Glands consist of a membranous network, on which blood-vessels ramify, endowed with the power of separating or *secreting* from the blood a peculiar fluid; the liver forming bile, the salivary glands saliva, the kidneys urine, &c.

The glands consist of two portions, the secreting portion and the conducting portion. In the one portion, in addition to the membrane, there are nucleated cells; in the other there are tubes. By the one portion, the fluid is formed; by the other, it is conducted to the place where it is required.

The essential material of the nervous system is denominated *Neurine.* Some anatomists still persist in calling it nervous matter, but it appears to me wrong to use *two* words where *one* expresses the thing to be described much better.

There are two kinds of neurine, differing in color, consistence, and microscopic character. They are easily recognized, and soon known to the anatomist. They are well seen in the brain of Man, and in the Mammalia generally. The one is of a gray or ash color, and pulpy texture, as seen by the naked eye, and roughly examined; and hence its title cineritious, or pulpy neurine. With the microscope it has been discovered to consist of nucleated cells or vesicles, and therefore more justly denominated *vesicular* neurine. The other is of a pearly white color and fibrous texture: this is medullary or fibrous neurine. The difference in texture depends, in all probability, more on the arrangement of the supporting membrane than upon any physical difference between their elementary particles.

Under the microscope, the fibrous neurine is found distinctly to consist of tubes, and hence its present title, *tubular neurine.* A third kind has been described to exist in those nerves which have been long known to the anatomist as the sympathetic. To the naked eye, this appears almost identical with the cineritious neurine of the brain, and has been generally classed as cineritious neurine; but it has been lately denominated, from its microscopic character, filamentous or gelatinous neurine. Its filaments are about half the diameter of those of the tubular, and without any distinct cavities. This neurine, as will be shown hereafter, is merely the tubular neurine without an investing layer.

The revelations of the microscope regarding the ultimate texture of these different kinds of neurine, are most deeply interesting, and quite determine the correctness of the view advocated in the first edition of this work, of their relative function. This view of the subject is now almost universally admitted; but in the year 1836, it was by no means an established point in physiology. The view to which I refer is this: that the cineritious neurine is the source of power, and the medullary neurine merely the conductor of it. The importance of establishing this position will be best understood when we come to the dissection of the human brain and spinal cord, and endeavor to discover the office of its component parts. Until this point was established, (and even now it is not considered to be so by all,) the study of the anatomy of the brain was barren and fruitless. Our predecessors had some glimmering of light on the subject, but their opinions were various and unsettled.

Lauth considered the gray substance as only a preparing organ. Treviranus says that it prepares the blood for particular processes which go on in the medullary substance. Vieussens, that it prepared and purified lymph as nourishment for the medullary substance. According to Berenger, it is said to assimilate the living spirits of the blood, and to metamorphose it into animal spirits. Sylvius imagines it evaporates the water from the spirits, as by distillation, and purifies them. Diemerbroeck, Ruysch, Haller, and others, entertained the same opinion.

Meckel says* that " the most probable hypothesis is that which represents the gray and medullary substances as two masses, the opposition or contrast of which results from the difference which exists in their structure and chemical composition, and is necessary to the accomplish-

* Vol. i. p. 256.

ment of the functions of the nervous system; and that, however incontestable the importance of the gray matter, it does not authorize us to believe that it is more noble than the medullary: that is to say, that in this portion the spiritual changes corresponding to the material pass into one another, as Wenzel appeared to believe when he says, 'Cinerea singularum cerebri partium substantia videtur præcipuè id esse, quo propriæ cuivis istarum partium sensationes efficerentur;'* and that the office of the medullary is not simply that of a conductor."

Not, however, agreeing with Meckel, but rejoicing to derive support to my opinions from such accurate observers as the Wenzels, I shall quote the whole passage: "Verisimiliter itaque diversor singularum cerebri partium functiones maxima saltem ex parte a cinerea, mutua autum singularum cerebri partium conjunctio, totiusque nervus a medullari substantia dependet; sive quod idem est: cinerea singularum cerebri partium substantia videter præcipuè id esse, quo propriæ cuivis istarum partium sensationes efficerentur, et substantia medullaris eadem modo pro reliquo cerebri ductor impressionum sive sensationum singularum cerebri partium esse videtur, non secus nervus sensorius id ipsum suo organo præstat."

Willis (Anatomy of the Brain, translated by S. Pordage, 1679, p. 59), says, "And what is chief of all, the universal cortical, or shelly substance of the brain, (to wit) in which the animal spirits are procreated." A little further on, he says, "The callous body is rather designed for the *circulation* than the generation of spirits." He considered that the animal spirits which the gray substance secretes, are circulated by the medullary. Reil, (Mayo, Physiological Commentaries, Part II. p. 117,) speaking of the fornix, says, "Like these, the corpus callosum involves no gray matter, and with them perhaps forms an apparatus for transmission only."

Even Gall and Spurzheim, who have done so much for the anatomy and physiology of the brain, did not see clearly the relation of the cineritious neurine and the medullary. They considered the former as the womb or generator of the medullary substance.

Tiedemann, as will be seen from the following passage, does not consider it as the sole agent in the *production* of power, but merely as an instrument to exalt and increase that which is already generated by the nerves.

"The quantity of gray substance," says Tiedemann, "in those parts of the spinal marrow from whence issue the large nervous trunks, and which receives so many vessels that Ruysch imagined it entirely vascular, contributes certainly, during life, to increase and exalt the nervous action, according to this general law, that an organ possesses more force and energy as it receives more arterial blood. M. Gall is deceived in saying that the gray substance, which he terms the womb of the nerves, is the first formed, being the producer and nourisher of all the nerves. I allow, with him, that it strengthens and fortifies the action of those parts of the brain and nerves which emanate from it, in as much as this effect is produced by the arterial blood which it contains, and by the greater rapidity

* De Penitiori Cerebri Structurâ, cap. vi. p. 69.

with which it repairs the loss which the exercise of the vital action produces. I admit, then, an intimate relation between the volume of the spinal nerves and the enlargements of the spinal marrow in those points from whence these nerves issue. It is very easy to be convinced of this in fishes, where the origins of the nerves produce particular ganglia, always when the nerves and the organs to which they are distributed have acquired a greater development, or when there are particular organs not found in other fishes. The remarkable and regularly disposed enlargements observed immediately behind the cerebellum in the flying-fish (*Trigla volitans**), are the origins of the nerves destined to the digitiform prolongations peculiar to these fishes, observed in front of the ventral fins, and provided with numerous muscles, serving at the same time as organs of touch and progression;† of this I have been convinced for some years. We find also in the torpedo (*Raia Torpedo*) two large ganglia, situated also behind the cerebellum, the size of which they much surpass, and from whence issue the nerves analogous to the eighth pair, which furnish a great number of branches to the electrical organs of these fishes. The *Raia clavata*, *Raia Batis*, *Raia Pastinaca*, and other species of the skate properly called, present but a very small swelling, giving origin to the eighth pair, which in these animals are only distributed to the gills. In the sheaf-fish (*Silurus*) the origin of the fifth pair of nerves forms a very voluminous mass, because this pair sends large branches to the long barbules which cover the superior maxilla, and to the muscles of these appendages. We find similar enlargements along the spinal marrow of most fishes.‡ Thus, for example, in the carp, there are behind the cerebellum two swellings, united together by a middle tubercle, and representing in some degree a second cerebellum. We cannot then doubt that the local augmentation of the mass of the spinal marrow, by the addition of a greater quantity of this substance, is to exalt the action or activity of the nerves which emanate from these ganglia."§

One of the first physiologists who decidedly advanced the opinion that the gray neurine is positively a source of power, was Dr. Fletcher,‖ of Edinburgh. In his Lectures, when speaking of the distinction between a plexus and a ganglion, he says, "The abundance of gray matter which they contain, and *which there is good reason to believe is always a primary source of some distinct faculty or power*, &c."¶ And again, in another part of the same course of lectures, he says:

"It is probable that no impediment whatever is offered to the function of a ganglionic nerve by such a division as entirely paralyzes the cerebro-spinal. Such is the case with the latter only; because the white

* Samuel Collins has described and represented them,—System of Anatomy, vol. ii. tab. 70, fig. 3.

† This I have demonstrated in a Memoir addressed to the Academy of Sciences at Berlin.

‡ Arsakay, *loc. cit.* p. 16. De posteriore Gangliorum Encephalum constituentum Parte.

§ Tiedemann on the Fœtal Brain, translated by Bennet.

‖ It is with great pleasure that I embrace this opportunity of expressing the high opinion I entertain of the late lamented Dr. Fletcher's talents and philosophical mind. Dr. Fletcher had the honor of being among the first, if not the very first lecturer in the kingdom who taught human physiology on the wide and scientific basis of comparative anatomy.

¶ Ryan's Journal, April 18, 1835, page 961, note.

matter of the nerve, being dependent for its energy upon the gray matter of the central parts of this system, becomes, of course, inert when separated from it: but no such line of demarkation exists in the ganglionic system, every point of every nerve of which contains white and gray matter intimately interwoven together, and may be considered, therefore, as a centre of nervous energy to itself; and it is in this way only that we can explain how the total removal of a muscle from the rest of the body, which implies a division as well of its blood-vessels as its nerves, is not for some time effectual in destroying its irritability."

As the student advances in the study of the structure and physiology of the brain, he will see many reasons for assenting to this view of the office of the cineritious neurine, which cannot be fully appreciated without a further knowledge of the subject than he is supposed to possess at present. We believe then that the peculiar power of the nervous system resides in the cineritious portion. In short, that the cineritious portion of the nervous system stands in the same relation to the rest of that system as the secreting portion of a gland does to the rest of that organ, though one portion would be useless without the other. The medullary or tubular neurine appears to act simply as a passive conductor of the power generated by the vesicular neurine, not possessing any control over that power, not capable of acting upon it or changing it.

Thus we find tubular neurine performing various offices:

1st. As a conductor of an impression from the surface of the body to the brain—a *nerve of sensation.*

2dly. As a conductor of an order to act, from the brain, to the voluntary muscles—*nerve of volition.*

3dly and 4thly. As a conductor of an impression from the surface of the body to the spinal cord, which is reflected thence down another set of conductors to the muscles whereby they are called into action, independently of volition—the *excito-motory nerves* of Dr. M. Hall.

5thly. As a conducting medium between the centres of power—the *commissures.*

Further explanation will be given hereafter of the function of the nerves of sensation, the nerves of motion, the excito-motory nerves, and the commissures. One simple pathological fact will now be sufficient to illustrate the distinction between the power of the nervous centres and their conducting instruments, and show that the central portion possesses its power independent of the peripheral. A patient may be paralytic from disease affecting the motor tract; the individual as perfectly retains the power of willing the motion of his limbs as previous to the occurrence of the disease, though his will is no longer conducted to the point where it would be executed. But this illustration does not, of course, afford the slightest explanation of the mode of action of these two parts, nor need it imply a belief in the necessity of a physical change for the production of nervous action.

Tubular or medullary neurine, though firmer than the cineritious neurine, nevertheless, in comparison with the other tissues of the body, is soft and yielding.

This want of tenacity is principally owing to the large quantity of water which enters into its composition; water actually constituting

from three-fourths up to seven-eighths of its weight. Vauquelin, whose analysis, though made as long ago as 1812, is still referred to by all our best authorities as most deserving of credit, states that the brain consists of

Albumen		7·00
Cerebral fat	Stearine 4·53, Elaine 0·70	5·23
Phosphorus		1·50
Osmazome		1·12
Acids, salts, sulphur		5·15
Water		80·00
		100·00

M. John* is the only chemist who, in his analysis of the brain, has hitherto separately examined the gray and white matter. He has stated that the white matter contains more fat than the gray, and that its albumen is more firm. The following comparative analysis was made of the brain of one of the insane patients who died at Salpétrière.

Entire brain (density = 1048).

Water	77·0
Albumen	9·6
White fatty matter	7·2
Red fatty matter	3·1
Osmazome, lactic acid, and salts	2·0
Earthy phosphates	1·1

	White Substance.	Gray Substance.
Water	73·0	85·0
Albumen	9·9	7·5
White fatty matter	13·9	1·0
Red fatty matter	0·9	3·7
Osmazome, &c.	1·0	1·4
Earthy phosphates	1·3	1·2

Foville states that the brain of a fat man contains a much larger quantity of fatty matter than that of a thin man; also that the brain of the Cetacea contains a large quantity of oil: that the brain wastes with the rest of the body; but the fat of the brain is combined in so intimate a manner with its substance, that it never forms solid and visible isolated masses external to the nervous matter.

"The presence of fat," says this author, "in proportion to its amount, gives a more rich form and more rounded contour to all the surfaces of the nervous centres. Its absence alters these forms, rendering them poor and sharp. With its absence coincides the increase of free serosity in the internal cavities, and those which separate the convolutions."†

He also in some cases attributes to emaciation the peculiar appearance

* Journal de Chimie Médicale, August, 1835.

† Traité complet de l'anat^e de la phys^e et de la path^e du système nerveux cercb^o. 8vo, 1844, par Foville, p. 122.

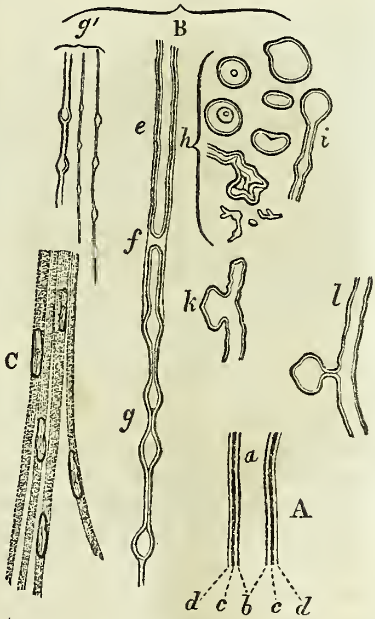
of the brain of old people, though at the same time warning us from confounding this appearance with true senile or morbid atrophy.

It has been stated that the relative quantity of phosphorus varies at different periods of life, also in healthy and diseased brains; that it is small in the infant and the idiot; but I do not feel satisfied that this assertion is established.

Professor Ehrenberg has shown that the medullary neurine actually consists of very minute fibres; and he informs us that these fibres can only be discovered by the aid of a magnifying power of 300 diameters, and that he was sometimes obliged to have recourse to a much greater magnifying power, as 800 diameters, in order to bring them into view. He examined thin slices of the recent brain, and states that the fibrous structure was in general most obvious at the margins of the slices. These fibres in the cineritious portion are interspersed with globules and plates; the greater number of these fibres, instead of having a regular cylindrical form, are knotted like a string of beads, the swelled portions being situated at some distance from one another, and united by narrower parts which are continuous with them, and are formed apparently of the same material.

It is now believed that this varicose appearance depends simply on pressure or other force used in preparing the objects. Still in some portions of the nervous system this beaded appearance is much more easily produced than in others, showing that it depends on some peculiarity of structure. It is most easily seen in those fibres which are most centrally situated, and in all probability depends on the greater delicacy of the protecting portion of the fibre, and also of the investing membrane. If the fibres which compose the fibrous neurine are examined with a good microscope, they will be found to have a peculiar and complicated structure. They are not simply solid fibres. They are perfect cylinders, varying in diameter from $\frac{1}{1000}$th to $\frac{1}{10000}$th of an inch. Their average width is from $\frac{1}{2000}$th to $\frac{1}{4000}$th of an inch. They are all invested and supported by a distinct elastic homogeneous membrane, similar to the sarcolemma of the

Fig. 1.

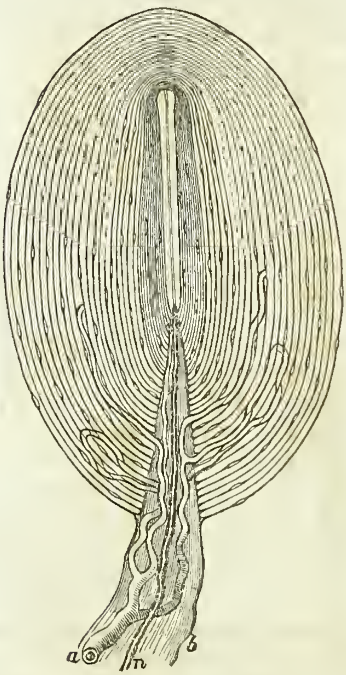


A. Diagram of tubular fibre of a spinal nerve. *a.* Axis cylinder. *b.* Inner border of white substance. *c c.* Outer border of white substance. *d d.* Tubular membrane. B. Tubular fibres. *e.* In a natural state, showing the parts, as in A. *f.* The white substance and axis cylinder interrupted by pressure, while the tubular membrane remains. *g.* The same, with varicosities. *h.* Various appearances of the white substance and axis cylinder forced out of the tubular membrane by pressure. *i.* Broken end of a tubular fibre, with the white substance closed over it. *k.* Lateral bulging of white substance and axis cylinder from pressure. *g'.* Various fibres of various sizes, from the cerebellum. C. Gelatinous fibres from the solar plexus treated with acetic acid to exhibit their cell nuclei. B and C. magnified 320 diameters. (Todd and Bowman.)

fibres of the voluntary muscles. The neurine which is contained within this membrane consists of two portions, a central, which is probably the active portion of tubular neurine, and an outer or investing portion, which possibly acts merely as an isolater of the conducting central axis. The central portion is called by Rosenthal and Purkinge, the *axis cylinder*. The outer portion is the white substance of Schwann.—(See fig. 1.)

The tubular membrane presents the same characters wherever it is met with. But the white substance of Schwann exhibits much variety as regards its thickness in different parts of the nervous system. In the nerves it is more developed than in the centres; but even in the former it differs a good deal as to thickness. We find it most developed in the ordinary spinal nerves; in those of pure sense it exists in small quantity. The chemical composition of the white substance, being obviously different from that of the axis, sufficiently denotes a difference of function in these two portions of the nerve-tube.

Fig. 2.



Pacinian corpuscle, from the mesentery of a cat, intended to show the structure of these bodies. The stalk and body, the outer and inner system of capsules, with the central cavity, are seen at *a*. Arterial twig, ending in capillaries, which form loops in some of the intercapsular spaces, and one penetrates the central capsule. *b*. The fibrous tissue of the stalk, prolonged from the neurilemma. *n*. Nerve-tube, advancing to the central capsule, there losing its white substance, and stretching along the axis to the opposite end, where it is fixed by a tubercular enlargement.

Stadelmann describes the axis-cylinder of the nerve-fibres as very distinctly visible in transverse sections of them. Its outline has commonly the same form, and is nearly half as large as that of the nerve-fibre itself; but sometimes it looks as a mere chink or a central point. It has been suggested, that the distinction of these two substances is merely the result of coagulation or chemical agents, and that it does not exist in the living organization; but Dr. Todd and Mr. Bowman, who have paid great attention to the microscopic anatomy of these parts, and from whom this account is derived, give the above as their deliberate opinion.*

There are certain little bodies, called Pacinian corpuscles, which in the human subject are found in great numbers in connection with the nerves of the hand and foot. In the mesentery of the cat, they may be seen with the naked eye, and under the microscope it exhibits the appearance of fig. 2, taken from the above work.—(Fig. 75, p. 397, Todd and Bowman.)

The discoverer of the Pacinian corpuscles states that the nerve filament has a single contour, like the sympathetic filaments: up to the base of the corpuscle, the contour is double; at its termination it presents a granular

* Physiological Anatomy of Man, 1845.

swelling, like the common ganglion corpuscle. Thus it will be seen that the central axis alone enters the central capsule. The envelope having, as it were, conducted the central portion to the door, leaves it, and stops outside. Thus we have, as Dr. Todd says, a natural dissection made for us. This fact renders his view of the office of the white matter still more likely to be correct.

Fig. 3.

Ideal representation of the nerve-tube entering a Pacinian corpuscle, to represent more clearly the distinction between the central axis and the envelope. s s. White substance of Schwann.

Nerve-tubes never branch like blood-vessels, and never inosculate with one another; though they form loops at their origin in the nervous centres, and at their terminations.

Often as I have traced these nerve-tubes under the microscope, I have *never* seen them join or anastomose, as we do the blood-vessels.

A nerve-tube always performs one and the same office; it always conducts in the same direction, and the same kind of nervous power: not at one time carrying impressions which, on reaching the brain, become sensations, and at another time conveying orders to a muscle to contract.

This last position is thus decidedly asserted, because I feel not the shadow of a doubt of its correctness; and to me it appears that all the important discoveries of Bell must be abandoned, if this be not true, and that we should then be more in the dark than ever regarding the physiology of the brain. Nevertheless, this position is actually disputed by some anatomists in the present day.

In an admirable article in the Medico-Chirurgical Review for July, 1845, page 1, the writer of it thus forcibly combats such opinions:—

"We certainly did not anticipate, and least of all in England, that a time would arrive when it would be necessary to vindicate the great principle announced by Bell, that principle upon which all accurate knowledge of the nervous system must ever repose, the individuality, namely, and uninterrupted continuity of the primary nervous filaments. Doubts have, however, been thrown upon this fundamental truth, and principally, as it would appear, on the faith of certain dissections and experiments of Stilling, from which it is inferred that the elementary fibres interlace one with another in the spinal cord, in the several nervous plexuses, and in other parts of the system; that, in fact, the disposition of the nervous system is precisely analogous to what is seen in the venous and lymphatic systems. We believe this to be an entire fallacy, and unhesitatingly express our conviction, resting on repeated and careful examination, that no anatomist has ever seen in any of the parts just mentioned, a true anastomosis in the sense of that existing in the vascular system. The only places where the primary nervous tubules do actually communicate is in their peripheral extremities, where, both in the muscles and in the tactile papillæ of the skin, they unite and form loops. It has also been asserted by Valentin, that a similar disposition prevails in the

central ends implanted in the gray matter of the brain, but, as we shall subsequently state, this must at present be held to be doubtful. . . . .

"The functions of the blood-channels and nerves are so totally different, that it is surprising any comparison between them should have been attempted. It is the office of the blood-vessels, not merely to carry the nutritive fluids to all parts of the body, but specially, by overcoming the repeated obstacles which impede the circulation, to secure in the extreme divisions or capillaries that uniform current which alone is compatible with healthy nutrition. Now, how is this to be accomplished? Clearly by providing free intercommunications between all the parts of the vascular system, and more particularly between its smaller divisions. Thus, as to the function of the blood-vessels, it matters not how the blood reaches its destination, provided it does but get there. But in the case of the nervous system, all is reversed; here the whole action of innervation requires in theory what is shown by observation, a disposition of the nervous threads, which will make them to act as isolated conductors, so as to transmit unmingled the mandates of the will centrifugally to special muscles, and centripetally the impressions made on the organs of sense to the brain. In consequence of the unsatisfactory results of many of Stilling's researches, we have again cautiously examined the disposition of the primitive tubes in the spinal cord, with the express object of ascertaining if, in any part of the white matter of the white substance, anastomosis could be detected. All our examinations have shown that the fibres invariably observe an isolated course. When viewed with a sufficiently high power, an objective of one-sixth of an inch focus for example, the beaded particles are beautifully and distinctly seen in a perfectly recent specimen, and mixed with their branches of minute blood-vessels and capillaries; these latter canals, it is necessary to state, present appearances so deceptive, that to an unpractised eye, and especially when low powers are used, as was done by Stilling, they may very readily be mistaken for nervous tubes, and herein, we believe, will be found the source of the errors above noticed. The capillary vessels are seen branching and uniting, but they present physical marks, and especially nuclei in their walls, which are quite distinctive: indeed, we were never more impressed with the certainty and elucidation which microscopic examination confers on the great questions of physiology, than by thus seeing under the eye the true characteristics of the vascular and nervous systems.

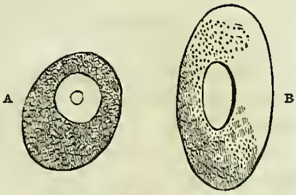
"The conclusion at which we have ourselves arrived, as the result of direct inspection, is confirmed by the best observers. Thus, Valentin, in his Physiology, just completed, after pointing out and demonstrating the physiological necessity of isolated conductors in the peripheral portion of the nervous system, both as relates to sensation and motion, says, we conclude, as a general anatomical proposition, that all ramifications, anastomoses, and interlacements of the nerves, are in reality only apparent, and therefore that no true divisions nor communications similar to those in blood-vessels exist, but merely a corresponding entrance or exit of unbranched, uninterrupted primitive fibrils; a disposition which enables us easily to comprehend the laws of nervous conditions."

Vesicular or pulpy neurine is much more vascular than tubular. Where

its capillaries are well filled with injection, it appears under the microscope like a minute network of countless blood-vessels.

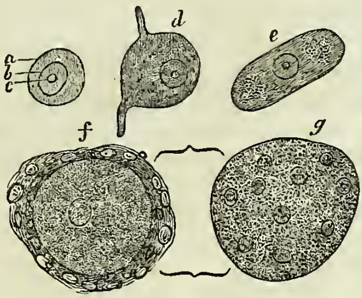
The neurine, which is deposited between the meshes of this intricate mass of blood-vessels, consists almost entirely of cells, with nuclei and nucleoli, (see fig. 4, A,) in various stages of development. The wall of every vesicle consists of an exceedingly delicate membrane, containing a soft but tenacious, finely granular mass. They are mostly globular, but not uniformly so. Some are caudate, and the tail prolongations are frequently long. In point of structure, say Messrs. Todd and Bowman, the caudate processes are exceedingly delicate, and finely granular, like the interior of the vesicle, with which they distinctly seem to be continuous. Such is the delicacy of these processes, that they readily break off; in general, very close to the vesicle. Sometimes, however, one or more of them may be traced to a considerable distance, and will be found to divide into two or into three branches, which undergo a further subdivision, and give off some extremely fine transparent fibres (fig. 5), the connection of which with the other elements of the nervous tissue has yet to be ascertained. It is most probable, however, that they serve either to connect distant vesicles, or else that they become continuous with the axis cylinders of the tubular fibres. In the cerebro-spinal centres, we have found the tissue in the vicinity of the caudate vesicles freely traversed in all directions by numerous very delicate filaments, which seem to be the ramifications of the caudate processes. These often exhibit considerable tenacity and elasticity. The situations from which we may obtain such caudate vesicles as are best suited for examination, are the "*locus niger*" in the crus cerebri, and the gray matter of the cerebellum and spinal cord.

Fig. 4.



A. Vesicle from the cineritious neurine of the brain of a frog. B. Blood corpuscle of the same animal, to show their relative size.

Fig. 5.



(Todd and Bowman, p. 212.) Nerve vesicles from the Gasserian ganglion of the human subject. *a*. Globular one with a defined border. *b*. Its nucleus. *c*. Its nucleolus. *d*. Caudate vesicle. *e*. Elongated vesicle, with two groups of pigment particles. *f*. Vesicles surrounded by its sheath, or capsule, of nucleated particles. *g*. The same, the thread only being in focus. Magnified 300 diameters.

Many of these cells are evidently of quite recent formation; so much so, that we cannot help observing the analogy in the microscopical structure of this portion of the nervous system and the secreting portion of the glandular system.

John Goodsir* has thrown great light on the part which the nucleated

* Anatomical and Pathological Observations, by John Goodsir and Harry Goodsir, 1845, page 7.

cell plays in the secreting process. It has been already stated, upon other grounds than those now to be advanced, that the cineritious substance of the brain stands in the same relation to the nerves that the secreting portion of a gland does to its duct. This theory appears to me now most curiously confirmed by the structure and functions of the intestinal villi.

To understand the part which the vesicles of the villus play in digestion, it is necessary to be aware of certain of the functions of the cell with which physiologists are yet unacquainted.

Not only are these bodies the germs of all tissues, as determined by the labors of Schleiden and Schwann, but they are also the immediate agents of secretion. A primitive cell absorbs from the blood in the capillaries, the matters necessary to form, in one set of instances, nerve, muscle, bone, if nutrition be its functions; milk, bile, urine, in another set of instances, if secretion be the duty assigned to it. The only difference between the two functions being, that in the first, the cell dissolves and disappears among the textures, after having performed its part; in the other it dissolves, disappears, and throws out its contents on a free surface.

In another place, he says,* "The ultimate secreting structure, then, is the primitive cell endowed with a peculiar organic agency, according to the secretion it is destined to produce."

The observations of Henle, quoted by that admirable physiologist, Dr. Carpenter, regarding the difference in the structure of the cortical substance of the brain, (*the hemispherical ganglion*,) all support this view. On the surface of the brain, that is, the portion of the ganglion which is nearest to the vascular network, the ganglion vesicles seem to be imperfectly formed. There is a finely granular substance containing spherical or oval vesicles, with one or two dark granules in them. In a rather deeper layer these vesicles, instead of being irregularly scattered through the granular substance, seem to have appropriated each to itself a portion of the latter for an independent covering; and from this condition there seems to be a regular gradation, till, in the yet deeper layers of the cortical substance, the vesicles, with their granular coverings, are replaced by perfect ganglion-like globules with their filamentous sheaths.

It is, then, most probable that the nucleated cells of vesicular neurine are the active agents in the production of nervous power; that they are developed, and perform their office, in the same way as the nucleated cells.

The enormous quantity of blood which the vesicular neurine receives, affords strong evidence that this structure, like the acknowledged secreting organs, employs that blood in the preparation of a something. Indeed, the effect of arresting the cerebral circulation shows most clearly that all the mental operations are dependent on the flow of blood through the brain, for their production. The experiments of Sir Astley Cooper on the rabbit are most interesting and satisfactory.

We have seen that neurine contains about one per cent. of phosphorus. The excessive excretion of phosphorus with the urine, after severe mental

* P. 25, *loc. cit.*

exertion—a fact first pointed out by Dr. Prout—may be cited as supporting this view of the analogy between the production of nervous power and ordinary secretion.

Dr. Golding Bird, in his excellent little work on urinary deposits, gives a very striking case, illustrative of this connection.*

"Where the presence of the triple phosphate is only occasional, its connection may be traced with some cause which has rendered the system morbidly irritable, at the same time that its tone or vigor has become depressed. The simplest examples of this kind that have occurred to me, have been in cases of individuals of nervous temperament, who have periodical duties to perform, requiring so much mental tension and bodily exertion. I have witnessed this state of things several times in clergymen, especially in those who, from the nature of their secular engagements, have been compelled to lead sedentary lives during the week, and to perform full duties on Sundays; the best illustration of this I ever met with, was in the person of a well-known and deservedly popular clergyman, who, from his connection with a public school, scarcely used any exercise during the week, whilst on Sunday he performed duty thrice in church. This gentleman was a tall thin person, of dark complexion, lustrous eyes, and almost phthisical aspect. He was the subject of constant dyspepsia. The urine passed on Saturday evening, as well as on Sunday morning, though repeatedly examined, was healthy, except in depositing urate of ammonia, and being of high specific gravity. Before his Sunday duties were completed, he almost invariably became the subject of complete fatigue, with a painful aching sensation across the loins, in addition to the flatulence and epigastric uneasiness under which he always labored. The urine voided before retiring to rest after the severe exertions of the day, was almost constantly of a deep amber hue, high specific gravity, and deposited the triple phosphate in abundance. The urine of Monday would contain less of this salt, which generally disappeared on the following day, and once more reappeared on the Sunday evening. I had an opportunity of observing this state of things for several weeks, and it ultimately disappeared by the patient relaxing from his duties and enjoying the amusement of traveling for a few weeks."

I have been frequently consulted by a gentleman in business, of a highly nervous temperament and excitable brain, on account of a deposit of phosphorus in his urine. In the morning this excretion is perfectly clear and healthy, but after he has been harassed by business, it then becomes cloudy. If, however, he is in the country, and free from anxiety of any kind, the water is then bright and natural. "Many circumstances," says Dr. Carpenter, "lead to the belief, that the nervous tissue, when in a state of functional activity, undergoes a rapid *waste* or disintegration, and a corresponding renewal."

My readers must not conclude from the above observations, that I consider mind to be dependent on matter. I believe that matter is merely the instrument which the mind employs, and I quite agree with my friend from whom I have last quoted, where he says, p. 83, "When

* Urinary Deposits, &c., by Golding Bird, M. D. 1844.

we speak of sensation, thought, emotion, or volition, therefore, as functions of the nervous system, we mean only that this system furnishes the conditions under which they take place in the living body."

The *gelatinous nerve* fibre was first described by Henle: it is flattened, soft, and homogeneous in appearance; containing numerous cell-nuclei, some of which are round, others oval; some situated in the centre of the fibre, others adhering to either edge, their longest diameter being generally parallel to the longitudinal axis of the nerve. These nuclei are arranged at nearly equal distances, and frequently exhibit distinct nucleoli. Sometimes these fibres show a disposition to split into very delicate fibrillæ. Acetic acid dissolves the fibre, leaving the nuclei unchanged. These fibres, containing nothing analogous to the white substance of Schwann, are devoid of that whiteness which characterizes the tubular fibre; and it would seem that the gray color of certain nerves depends chiefly upon the presence of a large proportion of the gelatinous fibres; hence they are sometimes called "*gray fibres.*"

The mode of connection of the gelatinous fibres with the elements of the nervous centres is, as yet, quite unknown. They are found in considerable numbers, in what are called the roots of the sympathetic, or the communications of that nerve with the spinal nerves; it has been supposed by Valentin that they are continuous with certain elements of the vesicular nervous matter.

These fibres are smaller in general than the tubular fibres; their diameter ranges between the $\frac{1}{6000}$th and the $\frac{1}{4000}$th of an inch. They resemble very much the fibre of unstriped muscle.

When I first read the description of this fibre, I confess I thought it improbable. We can understand the existence of one kind of neurine, for the *pro*duction of power, and another for the *con*duction of it. But I could never quite understand why there should be a different kind for the sympathetic nerve, and cerebro-spinal system, when it is clear that the same kind of vesicular or cineritious neurine performs twenty offices in different situations—for instance, in the spinal cord and in the brain; yet the microscope detects no difference of structure. It did, therefore, appear to me contrary to that beautiful simplicity which reigns throughout the animal organism.

Mr. Paget, in those admirable reports on physiology which are published in the British and Foreign Quarterly Medical Review, gives an excellent summary of the state of the discussion at present (July, 1846).

"Bidder and Volkmann, on the one hand, have maintained that there exists in the sympathetic nerve a set of *nerve-fibres*, characterized by their fineness, (they being only about half or one-third as large as the cerebro-spinal fibres,) their *paleness*, the *absence* of a *double contour*, their nearly *uniform contents*, and their *yellowish gray color* when in bundles; Valentin holding that the sympathetic *fibres* are neither in structure nor in relations peculiar."

"The most important contribution," says Mr. Paget, "to the physiology of the nervous system this year (1846), is from Kölliker.*

* Die Selbständigkeit und Abkangigkeit des sympathischen Nerven-system. Zurich, 1844, 4to.

"In the discussion of the question, Kölliker states, 1st, that the fibres described by Remak as peculiar to the sympathetic nerve, and which are commonly called Remak fibres, are, as Valentin has always held, not nerve fibres at all, but Neurilemma, consisting of imperfectly developed fibro-cellular bundles; 2d, he determines that Bidder and Volkmann are right in their description of the structure of fine nerve-fibres, or at least of the well-marked examples of them, and that these are not (as Valentin maintained that they were) Remak fibres. But he denies that these fine nerve-fibres are peculiar to the sympathetic system, or even so different from the common larger cerebro-spinal nerve-fibres, that they ought to be regarded as of a kind distinct from them. To justify this denial, he shows that the characters assigned to these fine nerve-fibres, as distinctive by Bidder and Volkmann, are neither definitely marked, nor constant, nor essential; that there is no real difference between these fine fibres and those of the brain, spinal cord, and nerves of special sense; that commonly the larger fibres assume near their peripheral end the size and other characters of the smaller ones; and that many fine fibres are found in all nerves, though it is generally true that there is a smaller proportion of them in the cerebro-spinal than in the sympathetic nerves.

"But, although it thus appears to be an error to speak of sympathetic and cerebro-spinal nerve-fibres as if they were two different *kinds* of fibres, yet the differences which do exist between them, and the various proportions in which the fine fibres occur, in different nerves, make it important to discern their origin and course. On these points, Kölliker first proves that these fine fibres have their origin, not only in ganglionic or nerve corpuscles of the sympathetic ganglia, but in those, also, of the ganglia on the cerebral and spinal nerves, and in the corpuscles of the brain and spinal cord. In this, his observations fully confirm those of Helmhotz, Will, and Hannover,* who, like him, have seen this mode of origin; and from Bidder and Volkmann, who, from another mode of investigation, concluded that fine fibres must thus arise. Kölliker has seen this mode of origin of nerve-fibres in the spinal cord, and in the spinal and sympathetic ganglia of the frog, in the spinal ganglia of the tortoise and cat, and in the Gasserian ganglion of the cat and guinea-pig. Hannover has found it in all classes of Vertebrata, and in many Invertebrata, in the brain and spinal cord, and in all kinds of ganglia; neither has he observed any other mode of origin besides this. The description given by Kölliker, of the spinal ganglia of the frog, is, that they contain one form of ganglion or nerve corpuscles, which are of simple shape, and give off no processes, and many other corpuscles, more or less pyriform, which, at their smaller end, are drawn out into a process. This process, like the corpuscles, is pale, and finely granular; it is from $\frac{1}{10000}$th to $\frac{1}{70000}$th of an inch in diameter, and, after proceeding about $\frac{1}{1000}$th of an inch, it rather suddenly acquires a dark contour and slightly granular contents: it is, in short, becoming a fine nerve-fibre. And in regard to those cases in which he has not seen this mode of origin of the fine fibres, Kölliker so far confirms or admits the truth of Bidder

* Recherches Microse sur le systême Nerveux; Copenhague, 1844, 4to.

and Volkmann, respecting the relative number of fine fibres, which enter and leave the ganglia, that he considers it proved that a great number of these fibres have their origin in the ophthalmic ganglion, and in the ganglion of the vagus of fish, and considers it as highly probable that the ganglia of the cerebral and spinal nerves of all the higher animals are also sources for similar fibres.*

"As to the relative proportions of large and fine fibres in the nerves, distributed to various parts, Kölliker concludes, from his own and other observations, that—1st, The nerves of voluntary muscles contain in their trunks a majority of large fibres, but in their peripheral distribution either only, or a majority of, fine fibres. 2d. The nerves of the skin contain (for the most part) equal numbers of both; but, in some of them, one or other size of fibres greatly preponderates, and, in all of them, the fine fibres greatly preponderate in their peripheral distribution. 3d. The nerves of sensitive mucous membrane are, in this respect, like those of the skin, except that in the nerves of the teeth, pulps, and the gums, there is a great majority of large fibres. 4th. In the nerves of involuntary muscles, and of the less sensitive or insensible mucous membranes, there is a great preponderance of fine fibres."†

From the above facts, it may be concluded that *nerve-fibres* of the sympathetic nerve differ from those of cerebro-spinal, in the absence of the white substance of Schwann; and this substance is found where the nerve is more exposed to pressure, or any kind of injury, from external causes. When the filaments of the cerebro-spinal have nearly reached their destination, then they cease to require the protecting material which was necessary in their course down a limb, and between the bodies of the muscles. The sympathetic nerve is generally deep-seated and well protected, and hence the absence of this protecting matter. We can easily understand what contrivance must be necessary to protect the delicate neurine when it has to travel, like the sciatic nerve, for instance, from the pelvis to the toes. Physically, it appears almost as strong as a tendon, and it had need to be so, exposed, as it is, in all the movements of the limb.

Its physical strength, then, and its power of resisting injury, are due to its investing membrane, and the presence of the matter of Schwann; while the essential portion of the nerve, that in which its vital powers reside, is the axis cylinder.

We all know, that even with all this bountiful provision, the nerves may be easily compressed so as temporarily to suspend their function. If we only fall asleep with one leg crossed over the knee of the other, so as to compress the popliteal nerve, when we awake we find our leg numb and powerless, until we have suffered all the pain of the feeling commonly called pins and needles, or live blood, as the nerve-fibres recover their power, and the nervous current is re-established.

* The most striking instance in which more fibres leave than enter the ganglia, is seen in the septum of the auricles of a frog's heart, which is so transparent that the ganglia and nerve-fibres may be counted in it. Here Bidder has often seen more fibres in one than in the other two branches from a ganglion; e. g. five in one, seven in the other. Volkmann, in Art. Nerven Physiologie, *l. c.*

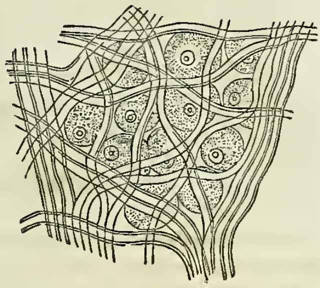
† British and Foreign Quarterly Medical Review, p. 273.

Sometimes when you are examining the nerve-tubes under the microscope, from the spinal cord of the frog, you will see the two kinds of tubes most distinct. The accompanying figure represents two of the gelatinous fibres, one twisted round the other. They were exactly the size of the axis cylinder of the ordinary fibres, as seen in the same field. This sketch was taken with Dr. Carpenter, through whose glass I observed them.—(Fig. 6.)

Fig. 6.

Gelatinous nerve-fibres in the frog.

Fig. 7.



(Todd and Bowman, after Valentin.)—A small piece of the otic ganglion of the sheep, slightly compressed; showing the interlacement of the internal fibres and the vesicular matter.

The nervous centres, or ganglion, consist of the vesicular neurine traversed by the tubular neurine.—(See Fig. 7.) This represents very well the appearance exhibited by a ganglion or nervous centre. Let it then be remembered that vesicular neurine does not exist in the nerves, and that, when these cords present a grayish appearance, as in the sympathetic, it is owing to the deficiency of the white substance of Schwann.

PART II.

COMPARATIVE ANATOMY.

The naturalist who devotes his time to observing the habits and instincts of animals, their external form and general appearance, pursues a branch of science which has unfolded a multitude of facts highly interesting and amusing to him who delights in the works of nature. But the physiologist follows in his pursuit of knowledge a more arduous and elevated path; for, not satisfied with observing the manners, actions and outward appearance of animals, he carries forward his researches to their internal organism, with the view of ascertaining the relation which structure bears to function.

Researches of this kind afford us the most important and valuable proofs which we possess, of the office of a nervous system in the execution of those acts which are exhibited to us by living beings. By such investigations the physiologist, discovering that the development of their internal organs corresponds with an increased capacity of enjoyment, the existence of which is demonstrated by their habits and instincts, obtains the only evidence which a science of observation like physiology is capable of affording, that they stand in the relation of cause and effect.

On this principle, I consider that the study of the anatomy and physiology of the human brain could not be introduced to the student in a more philosophical manner, or with a prospect of greater advantage to himself, than by taking an extended but general view of the nervous system of the lower orders of animals. I shall not enter with much detail into the immense variety of forms which the study of the nervous system of the whole animal kingdom presents to us, because I merely wish to use comparative anatomy as an ally in my attempt to simplify the study of the human brain, without regarding it, as it really is, as an object of extreme interest, independent of the service which it thus is capable of rendering to the student in medicine.

The celebrated Haller, who thoroughly felt the value of comparative anatomy in the study of human physiology, and the importance of taking this course, when reasoning on the functions of a nervous system, after observing that a brain and medulla spinalis are met with in animals with a head and with eyes, says, "Neque credo aut oculos absque cerebro, aut absque oculis cerebrum in ullo animale reperiri. Sunt ergo sua cerebra vermibus, mytulis," &c.

All physiologists of the present day agree in considering the nervous system as the medium by which animals are connected with the external world. And when, in our dissection of some of the inferior orders of

animals in whom there is an evident susceptibility to receive impressions from external nature, and to react upon those impressions, we are unable to demonstrate the existence of a nervous system, we come to the conclusion that the sentient matter which we call neurine is not absent, but developed in such minute quantity and so transparent that it escapes our observation.

The presence of a nervous system is not necessarily a proof of consciousness on the part of the animal in whom it is found. The invaluable and philosophic researches of Dr. Marshall Hall have quite established this most important fact, that all the actions which take place in man and animals in general, independent of volition, are as much excited and guided by the nervous power as those which are directed by the will. For instance, all the complicated acts of swallowing are as much dependent on the nervous system as the act of raising the food to our mouths. These important discoveries of Dr. Hall will of course be more fully considered in relation to the cerebro-spinal system of man; but I cannot mention his name without expressing the regret I feel, that the most important contribution to physical science, since the discovery of Bell, should have been passed by unnoticed and unknown by that scientific society, whose object is to promote science and reward real merit. These researches of Dr. Hall have been rendered still more valuable by those of Mr. Grainger, Dr. Carpenter, Mr. Newport, and others, who have shown that one of the most important functions of a nervous system, as regards the vital existence of an animal, is to receive impressions, and to react on such impressions, independent of the consciousness or the will of the individual. This fact will be found universal in its application. Wherever the wants of an animal require a consent in the action of its organs, such actions are called into play, and superintended and controlled by a nervous system. If we examine the organization of the simplest animals, we find that it consists of little more than a stomach for digesting food, and arms for the collection of it. There must, however, be a consent between these organs of digestion and collection, and we find in them a nervous system to effect it. As we ascend in the animal kingdom, we find other organs added to those of mere digestion and collection, or prehension, and with them a more complicated nervous system; so that, in fact, the size and complexity of the nervous system are a good criterion of the endowments of the animal, and its relative position in the scale of animated existence. And the nervous system is now universally allowed to afford the best principle for the classification of animals. The animal kingdom has been divided into five grand divisions, or sub-kingdoms, and named in accordance with the form and arrangement of the nervous system.

1st. The Cryptoneura of Rudolphi, or the Acrita of MacLeay.

2d. The Nematoneura of Owen, Cycloneurose of Grant, Radiata of Cuvier.

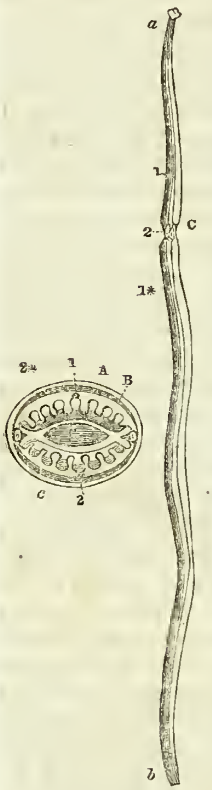
3d. Homo-Gangliata of Owen, Diploneurose of Grant, Articulata of Cuvier.

4th. Hetero-Gangliata of Owen, Cyclo-Gangliata of Grant, Mollusca of Cuvier.

5th. Myelencephala of Owen, Spini-cerebrata of Grant, Vertebrata of Cuvier.

In the first of these divisions the nervous system is indiscernible, and neurine, if existing at all, is so minute in quantity, and so transparent, that it cannot be demonstrated as forming a separate system. In the second, the Nematoneura, the ganglia are so extremely minute that the whole presents a mere thread-like appearance. But the term is applicable only as designating the appearance, and not the actual structure; for in these animals, Ganglia, Commissures, and Nerves, the three elementary portions of every nervous system, though scarcely visible, exist as perfectly formed as in the highest animals. Thirdly. In the Homo-Gangliata the ganglia are generally of nearly equal size; none decidedly exceeding any of the rest. Fourthly. The Hetero-Gangliata are so named from the singular manner in which the ganglia are scattered through the body. Fifthly. The Myelencephala include all animals with a perfect brain and spinal cord.

Fig. 8.



1* Female Ascaris seen on its abdominal surface. *a.* Mouth surrounded by three tubercles. *b.* The anus. *c.* Contracted portion found at the union of the anterior third of the body, with the two posterior thirds. 1. Abdominal nerve. 2. Vulva.

2* An enlarged view of a transverse section of the same worm. A. The skin. B. Two muscular layers. *c.* Cavity of the stomach. 1. Dorsal nerve. 2. Abdominal nerve.

It will generally be found that the Nematoneura are the most simple; the Homo-Gangliata the next, and so on. But this is not uniformly the case; for the nervous system, to which, as being the most simple, it will be desirable first to direct our attention, is taken from the Homo-Gangliate division. But it is not improbable that the simplicity in this instance arises solely from its being imperfectly developed or in a rudimentary state, and may perhaps, therefore, be considered as affording an imperfect type of a nervous system.

As my present object, in alluding to the nervous organization of the lower orders, is not, as I have said, to carry my readers minutely into the subject, but solely to make the study of the human brain more simple and interesting, I shall confine myself to the description of the most prominent features in each division.

The most simple form in which we find the nervous matter arranged so completely as to constitute a distinct nervous system is in the Ascaris, a species of intestinal worm; we can scarcely conceive an animal having its relations to the external world more limited than this; it has not even to seek its food beyond the narrow spot to which its existence is confined, and can therefore have little necessity for a nervous system, and we find it accordingly but imperfectly developed. Jules Cloquet has given us the best account of the nervous system in these animals: it is from a work published by him on this subject, in 1824, that the following account and drawing were derived. Two white cords, rather thicker in the middle of the body than at the extremities, composed of a series of

small lines united at angles, or, as it were, broken and slightly swollen at each angle, sending to the right and left filaments so thin that they escape the eye, except when seen through a magnifying lens, constitute their nervous system. These cords are situated within the plane of the muscular fibres, and descend, the one on the abdominal, the other on the dorsal, surface of the alimentary canal. The abdominal nerve forms a circle around the vulva of the female, as will be seen by reference to the diagram; the slight enlargements Cloquet regards as ganglionic.

Laënnec, Otto, Lamarck and Cuvier all agree with Cloquet in considering the lines above described as the nervous system. Nevertheless it appears to me extremely probable that these cords do not represent a perfect type of a nervous system, even in its most simple form, but that in this individual it has been arrested in its development at a period corresponding to one of the regular stages through which the nervous system passes in the higher orders, in whom we know that the nerves are developed first, and the centres or ganglia afterwards; and in this animal, where the ganglia scarcely exist, is it not possible that the organization is incomplete; that the animal, in fact, is not perfect; that the conducting portion of the nervous apparatus has been formed, but not the point from which the power emanates, requiring to be conducted?

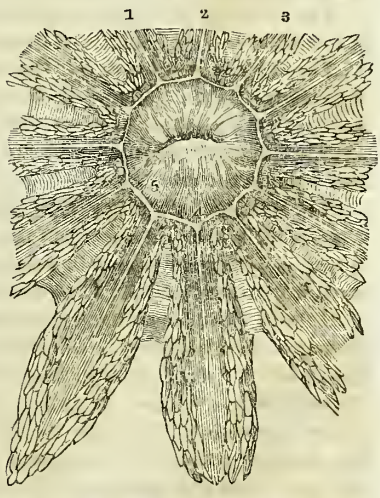
Fig. 9.

Ovum of the chick, 24th hour. (After Dr. Allen Thomson.) The white line represents the rudiment of the nervous system.

The above simple arrangement perfectly corresponds with the first appearance of the cerebro-spinal axis during development of the vertebrated class of animals, and affords a beautiful illustration of the law, that the higher classes of animals, during their development, go through some of those forms which are permanently retained by the lower orders. About the twenty-fourth hour after incubation has commenced in the egg of the common fowl, the rudiment of the spinal cord may be seen in the form of two white lines (see fig. 9), perfectly similar in appearance to the nervous cord in the Ascaris.

Let us next direct our attention to the nervous system of one of the Asterias; it is beautifully simple, and not the less instructive; for whether we regard the motions of this animal as the result of volition or not, they are evidently regulated, and not accidental. It has the power of locomotion, and will adapt the position of its rays, one after the other, to the crevices of the rocks, where it seeks and obtains its food; and when in accordance with this power of apparently commanding the execution of

Fig. 10.



Nervous system of the star-fish, drawn from a preparation in King's College Museum. 1, 2, 3. Nerves distributed to three of the rays. 4. One of the twelve ganglia. 5. One of the commissures.

certain offices in different portions of its frame, we detect nervous cords emanating from nervous nodules, we are induced to regard them as instruments employed in the production of these phenomena. Tiedemann was the first to prove decidedly the existence of a nervous system in the star-fish. His account was published in 1816,* accompanied with a beautiful drawing of it, representing a ring surrounding the œsophagus, giving off a filament to each ray, besides ten smaller ones, which he believes to descend to the stomach; at the same time he observes that he could not discover anything like ganglia. Their existence has, however, been since distinctly proved; and in an excellent preparation of the twelve-rayed star-fish in the Museum of King's College, twelve little nodules of neurine or ganglia, one opposite each ray, may be distinctly seen, from which fig. 10 is taken.

This nervous system, simple as it is, forms an accurate type of the most complicated in the highest species of animated beings, containing, if I mistake not, exactly the same number of elements; and the distinct portions to which we must now attach different names, should peculiarly engage the student's attention when thus presented to his observation under this the most simple form. When called upon to trace the same arrangement in the human being, he will be in danger, from the greater number of similar parts closely connected together appearing to do away with this fundamental simplicity, of being lost in the labyrinth of perplexing obscurity, which seldom fails to disgust those who attempt to learn the structure of the brain in the ordinary method.

The three portions may be designated, ganglia or nervous centres, commissures, and nerves.

The small swellings or nodules of neurine, are the *ganglia.*

The cords which pass between the different ganglia, and thus connect them together, are the *commissures*, or apparatuses of union.

The cords which are connected to the ganglia by one extremity, and the textures of the different organs by the other, are the *nerves.*

The term ganglion is not the best that might be devised for the designation of this portion of the nervous system, as merely signifying a knot: it only characterizes its external appearance, without in the slightest degree implying its function as distinguished from the nerves and commissures.

But as it seldom answers to attempt a decided change in the nomenclature of a science like anatomy, which has existed for so many years, it will perhaps be better to employ the same term in the comprehensive meaning which comparative anatomy justifies us in adopting.

Human anatomists have been too much in the habit of considering a peculiar rounded form essential to the constitution of a true ganglion, not usually, therefore, applying the term ganglion to a collection of cineritious matter, unless moulded into a knotted form and supported by a dense membrane: thus the medical student has been led to imagine that the neurine which is contained within the human skull, is altogether different from the ganglia of the lower orders of animals, merely because it differs from them so much in its outward appearance.

* Anatomie der Röhren-Holothurie des Pomeranzfarbigen Seesterns und Stein.

But the fact really is, that if the term ganglion be correct as applied to the nodules of neurine or centres of power in the lowest animals, it is equally correct to apply it to those of the highest; and it therefore follows that the human brain is but a series of large ganglia. Their close connection, and the great size of the commissures, give to it a degree of complication which we can only unravel, by seizing the thread at this simple though perfect type of a nervous system, and never dropping it till it has conducted us through all the various additions made to its fundamental simplicity, up to the perfect but complex organization in the human being.

That a peculiar form is not indispensable to the constitution of a ganglion, even according to the confined sense in which that term is used in the descriptive anatomy of the human body, is proved by the fact, that a simple layer of cineritious neurine of a semilunar form, lying between the dura mater and skull in the temporo-sphenoidal fossa, through which the posterior root of the fifth pair of nerves passes, is described as being perfectly analogous to the rounded firm knots which are attached to the posterior roots of all the spinal nerves; and the analogy is perfect: but it ought to teach us this lesson—that a particular form is not essential to the constitution of a ganglion. I think, therefore, that we are justified in extending the term ganglion ; and I am quite sure that it would enable us very considerably to simplify the anatomy of the human brain, if we were to apply it thus to any collection of cineritious neurine into a circumscribed mass, whatever form or arrangement it may assume: for instance, the cineritious neurine which forms the convoluted surface of the hemispheres of the human brain, I should denominate the Hemispherical Ganglia; for the convoluted appearance arises solely from the circumstance, that it was necessary a contrivance should be adopted to pack a very extensive surface into a small space, on the same principle, (and I trust that the homeliness of my simile will be excused for its simplicity,) that when we put a handkerchief into our pocket, we fold it up instead of attempting to carry it about us spread out to its whole extent. Now there would be just as much reason to deprive the semilunar ganglion of its generic title, and give it a name merely in accordance with its appearance, as there is in separating the hemispherical ganglia of the human brain from their analogous ganglia in the lower animals, and designating them by a term which gives a mystery to their character they do not deserve.

It is a great pity that anatomists cannot agree upon some generic title for the *cortical* substance of the human brain, so as to distinguish it from the tubular neurine which, with it, forms the *hemispheres* of the *brain.* It is a distinct ganglion, and as such ought to have a name ; I gave it that of hemispherical, because it appeared to me the best that could be adopted : and I think so still ; but if any other anatomist had re-named it well, I would have followed him in this edition, sooner than leave it without a name. There would be just as much sense in calling the *occipito frontalis muscle* the *cortical substance of the cranium*, as there is in calling the *hemispherical ganglion* the *cortical substance of the brain.*

When the physiologist is engaged in the difficult task of discovering the office of any particular apparatus in the organism of an animal, there

are few proofs which are so clear and satisfactory as those derived from some decided peculiarity of structure: as a simple instance, we may cite the tubular form of arteries and veins, convincing us that they are intended to carry fluids, and the valves in the interior, proving to us that those fluids could only flow in one direction. Now in our investigations into the functions of a ganglion as distinguished from the other portions of the nervous system, it is true that we shall not be able to derive, from the study of its structure, proofs of its function so clear and decided as those just cited in reference to the circulating system. The gray or pulpy neurine is always met with in a ganglion, and the fibrous alone enters into the composition of a nerve, while the commissures are occasionally compounded of the two. This circumstance, independent of all that has been already advanced, to prove that the nervous power is generated by the vesicular neurine, would be almost conclusive.

If it be true, that the cineritious matter alone is endowed with the faculty of generating or producing power, while the medullary is simply capable of conducting it, we must conclude that the nerves are not only the instruments of conduction, but that those portions of the human brain which are formed of medullary neurine must perform exactly the same function, and that the great transverse commissure or corpus callosum, the longitudinal commissure or fornix, and in fact all those commissures into whose texture the medullary neurine alone enters, must necessarily be conductors and not originators of the peculiar powers by which the nervous system is distinguished from every other. Is it not then extremely probable that the office of the commissures is to enable the individual to compare those impressions which are conducted by the nerves of sensation, from the especial organs of sense in which they originate, as the eye and the ear, to the hemispherical ganglia, the seat of judgment, memory, &c.?

The vital phenomena which living beings present to our observation are of two kinds: the one comprehends all those functions which tend to the maintenance and preservation of their individual existence, and the reproduction of their species; while the other class of phenomena bring them into relation with the external world, informs them of the existence of surrounding objects, and, manifested in the activity of the intellectual faculties, teaches man in particular the properties of bodies and the laws which regulate them. Those functions by which the nutrition and growth of individuals and the reproduction of species are effected, are common to all living beings, vegetables as well as animals, and there can be no life without them; but the second order of functions, the manifestation of which proves to us that the individual is capable of receiving impressions from external nature, and of reacting upon these impressions, showing thereby a consciousness of their existence, is peculiar to animals.

All true physiologists, even from the time of Aristotle, have observed more or less accurately the distinction between these two classes of phenomena, and arranged them accordingly. Aristotle conceived that they might be classified under three heads—vital, natural, and animal; the first two comprehending those which we now combine under the head of vegetable life.

Galen adopted the same arrangement, but added the hypothesis that these functions were superintended or controlled in their operation by presiding spirits; something in the same way that some physiologists of the present day believe in the existence of a single *vital principle*, whose office it is to effect all the various vital phenomena which are presented to our observation by living beings.

Bichat arranged the functions, like many of his predecessors, under two heads; but instead of referring the power, which appears to regulate and preside over these phenomena, to some mysterious spirit, he considered it to be dependent for its very existence on the nervous system; and this led him to divide the nervous material into two systems, the one of which he called the nervous system of organic, perhaps better called *vegetative life*, and the other of *animal life*.

The first of these systems in man was formerly designated the *sympathetic nerve*, from a belief that it arose from the brain in a similar manner to the cerebral nerves in general. Its title of sympathetic was owing to the idea that the sympathy which exists between all the vital organs was dependent for its existence on this nerve. The idea that it arises from the brain is erroneous; for it differs from the cerebral nerves as completely as the brain and spinal cord themselves do from the nerves which arise from them. And the notion being rejected, it has since been called the ganglionic system—a name which I think objectionable, in as much as it might lead the student to imagine that those nodules of neurine called ganglia were peculiar to this system, which, as he advances in his studies, he would find to be erroneous.

It has appeared to me that, in describing this portion of the nervous system in man, it would be better to designate it the *Cyclo-ganglionic* or hetero-ganglionic system, as corresponding in its mere anatomical arrangement with the nervous system of the cyclo-gangliated or molluscous division of the animal kingdom.

Physiologists were divided in opinion as to which of the two systems, the sympathetic or the cerebro-spinal, the nervous apparatuses of the lower orders ought to be referred. Before the sympathetic system had been acknowledged in man and the lower animals as distinct from the cerebro-spinal system, every appearance of a nervous system was very naturally considered as corresponding to the cerebro-spinal.

But after the sympathetic system was admitted to be independent in its powers in man and the higher animals, physiologists, looking only to resemblance in outward appearance, and not to analogy of function, began to maintain that the nervous system of the lower orders corresponded exactly to this, the system of vegetative life of the upper.

It is now, however, generally believed that where a distinct nervous system is present, and there is an evident separation of the animal from the organic or vegetative functions, in all probability there are three presiding nervous systems:

1st. The cerebral or brain system.

2d. The true spinal or excito-motory system of Dr. M. Hall.

3d. The sympathetic or cyclo-ganglionic system, the system of organic life of Bichat.

And though it is difficult, most probably on account of its minuteness,

in many of the lower animals, to demonstrate the existence of the nervous system of vegetative life, as distinct from that of animal life, there is very little doubt that it always exists; and it has, in fact, lately been demonstrated in many of the lower orders where its presence was not previously even suspected.

Dr. Grant, in speaking of the nervous system as developed generally in the animal kingdom, says—"The nerves of sensation and motion closely accompany each other, forming by their union, cords or columns, or a cerebro-spinal axis; but the sympathetic nerves, appropriated to the more slow and regular movements of organic life, form a more isolated system, and these three systems are developed together, almost from the lowest animals."*

The following literary history, from Dr. Fletcher's Lectures, of the opinions held concerning the uses of the ganglionic nerves from Galen to Brachet, is so excellent and comprehensive, that I think its introduction in this place will be acceptable to my readers. "Before the time of Galen the ganglionic system of nerves was entirely unknown; and although by him and his followers, the Arabians, the existence of this system, as well as its supposed origin from the superior maxillary branch of the trigeminal nerve, was pointed out, as well as its other supposed origin from the abductor nerve was subsequently by Eustachius, it was not till the time of Willis that the ganglionic nerves were generally considered as a part of the nervous system at all.

"Willis, however, still looked upon them as merely an appendage to the cerebro-spinal system, and represented them, both in verbal descriptions of them and in his curious diagrams of their distribution, as growing upon the latter 'ut frutex super alio frutice.' And this notion having been adopted by Vieussens (Neurograph., 1684), Lancisi (Opera Omnia, 1745), Meckel, senior (Mémoires de Berlin, 1745), Zinn (ditto, 1753), Hoare (De Gangliâ Nervorum, 1772), Scarpa (De Nerv. Gangl., 1779), Monro (On the Structure and Function of Nervous Ganglia, 1783), Blumenbach (Inst. Physiol., 1786), Chaussier (Exposition, &c., 1807), Legallois (Sur le Principe de la Vie, 1812), Béclard (El. d'Anat. Gén., 1823), Wilson Philip (On the Vital Functions, 1817), Mason Good (On the Study of Medicine, 1825), and numerous other writers, both before and since the time that their independence was insisted on by Winslow, it has become a very prevalent custom to regard these nerves as of very secondary importance; and the names imposed upon the system in general, as well as the uses assigned to it, have generally corresponded with this idea.

"The ganglions of the sympathetic nerve were supposed by Galen, their discoverer, to act as buttresses, in order to strengthen them as they recede from their reputed origin; by Willis as a kind of diverticula to the animal spirits received from the brain, and also as a means of keeping up a sympathy between distant organs: Vieussens and Meckel adopted the same opinion.

"Lancisi looked upon them as forcing-pumps adapted to propel the animal spirits along the nerves.

* Outlines of Comparative Anatomy, Part II.

"The doctrine of the independence of the ganglionic system was espoused by Cuvier (Leçons d'Anat. Comp., 1799), and particularly insisted on, with his accustomed eloquence, by Bichat (Sur la Vie et la Mort, 1802), who represented all the ganglions of this system as 'des centres particulièrs de vie organique, analogues au grand et unique centre de la vie animale qui est le cerveau;' and who further demonstrated, not only that all these ganglions were collectively independent of the cerebro-spinal system, but that each ganglion was independent of every other; nay, that each nerve proceeding from such a ganglion was in a great measure independent of that ganglion, and even that each point of such nerve was independent of all the rest, and constituted, *per se*, a distinct focus of nervous influence.

"Richerand (Phys., 1804), and Gall (Anat. et Phys. du Syst. Nerv., 1810), adopted similar tenets; and they are further inculcated by Wutzer (De Corp. Hum. Gangl., 1817), and Broussais (Journal Univ. des Sc., 1818), the latter in particular describing the ganglionic system of nerves as possessing a peculiar kind of sensibility (*i. e.*, irritability), with which it immediately endows all the organs destined for nutrition, secretion, and the other organic functions, and, by means of its repeated connections with the cerebro-spinal system, all organs of the body.

"Brachet, in an especial manner (Sur les Fonctions du Syst. Nerv. Gangl., 1823), distinctly represents the ganglionic system of nerves as the seat of 'imperceptible sensation,' and as presiding in an especial manner over the several viscera of the body."

In directing our attention to the relation which the development of the nervous system bears to the manifestations of consciousness in each individual of the animal kingdom, it is interesting to observe the relative position which the nervous system, in its simplest form, holds to the alimentary canal: we must not, however, attempt to account for this circumstance by supposing that the presence of a nervous system is necessary to the solution, digestion, and assimilation of the alimentary matter; for these processes are perfectly executed by the fresh-water Polypus, or *Hydra viridis*, in which there is not the slightest trace of a nervous system. Almost the whole existence of the lowest order of animals appears devoted to the acquirement of food and the reproduction of their species; apparently they answer no other end in creation than that of elaborating a nutrient material for others that hold a higher rank in the animal kingdom; and the whole of their vital energies being devoted to this object, we cannot be surprised that those organs which are expressly constructed for its fulfilment, should be surrounded by, and thus intimately connected with, that system (the *nervous*) by which the animal is informed of the existence of surrounding things, and is fitted to act upon these to the extent of its limited necessities.

In the animal which we have last described, the star-fish, it is evident that one of the earliest forms of nervous system which is cognizable to our senses presides over the motive apparatus of the animal. But, let it be remembered, it does not follow that such motions necessarily indicate any volition or consciousness on the part of the animal executing them. The nerves of the star-fish, like the spinal nerves in man, may most probably be divided into two classes, the *excito* and the *motory*, or

the incident and the reflex ; the motor nerves arising in the ganglia, and distributed to the arms,—the excitor arising round the mouth, and terminating in the ganglia. In this individual all the ganglia are of equal dimensions, none predominating in size over, or differing in function from the rest ; there is no concentration of power : all is equally diffused. The office performed by the nervous system, even of this simple animal, cannot be understood without a further knowledge of Dr. M. Hall's view. Our readers will then be better prepared to understand the function of the various ganglia of the Articulate and Molluscous divisions of the animal kingdom. They will also, after seeing these ganglia scattered about the bodies of the lower animals, again recognize them in a more concentrated form in the human being, and thus receive a clue to their analogies in the human being, when they are presented in a more concentrated form. Dr. Marshall Hall, in the preface to his first work on this subject, thus states his views: "First. That there is a source of muscular action equally distinct from voluntary motion, and from motion resulting from the irritability of the muscular fibre. Second. That there is a series of incident *excitor nerves*, and of reflex *motor nerves*, which, with the true *spinal marrow* as their centre or axis, constitute the *true* spinal system, as distinguished from the *cerebral*, through which that muscular action is excited. Third. That the *ingestion* and *egestion* of air and of food, and the action of the *orifices* and *sphincters* of the body, are dependent upon this system. No physiologist has observed that the action of the *larynx* and *pharynx* in *deglutition* and *vomiting*, and in *respiration*, and that of the *sphincters*, continually depends upon the *spinal marrow* and certain *excitor* and *motor* nerves.*

"The eyelids close when the eyelash is touched, through the same agency of *excitor* and *motor* nerves, and of the spinal marrow."

Respiration has been shown to depend upon the medulla oblongata. But this part of the *spinal marrow* has been erroneously supposed to be the *source* and *primum mobile* of this function ; whereas Dr. M. Hall believes he has ascertained that the pneumo-gastric is that *primum mobile*, as the principal *excitor nerve* of respiration :

"The action of the ejaculators obviously depends upon the same *excito-motory* or true *spinal system*."

The fourth of Dr. Hall's views is, "That the true spinal system is the *exclusive* seat of *convulsive diseases*."

The fifth is, "That the same system is the seat of action of certain *causes of disease* and of certain *remedial agents*."

Legallois† and Mr. Mayo‡ have shown "that distinct portions of the spinal marrow have distinct functions ; but these functions have been confounded with *sensation* and with *voluntary* and *instinctive motion*, and have remained both unexplained, and without any application to physiology or pathology."

Dr. Hall left to others the task of applying his principle to the elucidation of the physiology of the nervous system of the lower animals.

* In order to see the proofs of this remark, the reader need only turn to the justly popular works of Mayo, "Physiology," ed. 3, pp. 113, 114, 361, &c.; and of Magendie, ed. 3 & 11, pp. 65—68, 132, &c.

† Œuvres, Paris, 1824, p. 62, &c.

‡ On Human Physiology, pp. 230, 231.

Mr. Grainger was the first who pointed out the instruments by which these excito-motory actions are performed in man, and their analogues in the lower animals.

In his admirable work on the spinal cord, he thus expresses himself: "The anatomical characters of the invertebrated animals afford, however, the most striking evidence of the true formation of the spinal cord, and corroborate, in a manner not to be mistaken, the account that has been given in the preceding pages, of the anatomical arrangement of the spinal nerves. In the immense division of the Articulata, it is found that the nerves of the body are attached to masses of a granular gray substance, but hitherto the true relations existing on the one hand between the nerves and these masses, and on the other hand between the latter and what is considered as the brain, have not been determined. A careful examination, however, of that descending and, as it were, graduated scale which is formed by the nervous system in the animal kingdom, consequently demonstrates that the Articulata possess parts which are the exact analogues of the structures that exist in the Vertebrata. It was surmised by Sir C. Bell, that there exists, from the worm up to man, a series of nerves subordinate to sensation and volition, constituting what that profound physiologist called the regular or symmetrical nerves, —a supposition which has been in part realized by the beautiful discovery of Newport, who has proved the identity of the gangliated thread of the Articulata with the spinal cord of the vertebral animals. This writer has not, it is true, referred to any division of the motor and sentient nerves into two orders of fibres, similar to those which are capable of demonstration in the Vertebrata, nor have I been hitherto able to detect such an arrangement; but, when we consider the remarkable intricacy and minuteness of the whole structure in these animals, and recollect how lately even the two roots themselves have been discovered, it may be well permitted us to doubt if the entire anatomy of these nerves is yet known.

"It is seen on inspection that the nerves are attached, as has already been stated, to the ganglions, which bodies are themselves connected by a few delicate longitudinal threads, which also extend from the uppermost ganglion to the brain. Now from the analogy of the vertebrated animals, it may be assumed that these threads consist in part of longitudinal commissures, by which the ganglia are combined in their functions, and in part of true sensiferous and volition filaments, which terminate in the brain. In descending the scale, from the most perfect animal to the lowest classes in which a symmetrical nervous system exists, it is seen that exactly as the motions of the body become independent of the brain, the nerves contain a larger proportion of those fibres (the true spinal) which terminate in the substance of the spinal cord, and fewer cerebral. But it is most erroneous to assert, as some authors have done,* that in the invertebrated animals the spinal cord is not directly continuous either with the brain or with itself; on the contrary, wherever there is a gray mass in the head, however minute, which corresponds in office with the brain, a connection with the nerves through the medium of the spinal

* Fletcher's Rudiments of Physiology, Pl. 2 b, p. 87.

cord is indispensable to the exercise of that voluntary control over the motions of the body which in these instances always exists.

"In the invertebrate animals thus endowed, there is in fact no difference in the type of the cerebro-spinal axis, when contrasted with that of the Vertebrata; there are innumerable varieties of form, but in every instance the essential structures have a real existence."*

Dr. William Carpenter followed Grainger in this path, and in the fullest and in the most philosophical manner has brought the anatomy of the Mollusca to elucidate this subject. Dr. Carpenter enunciated his views in his inaugural Thesis, printed in 1839.†

I shall avail myself largely of its contents in the following observations on this subject. In his Introductory Remarks he says, "One of the principal objects which the author has kept in view, has been to ascertain how far Dr. M. Hall's doctrine, regarding the distinctness of the *excito-motor* from the *sensori-volitional* system of nerves, accords with the data furnished by comparative anatomy."

One great advantage to be gained by studying the nervous system of the invertebrate class of animals is, that the centres are so completely isolated, and the nerves which they distribute so easily traced, and the organs they supply, that it is much easier to discover the probable office of each individual ganglion than it is in man, where they are so closely packed, and the connections of all so numerous, that it is not easy to decide so accurately over what organs, or sets of organs, each nervous centre presides.

Our next illustration shall be selected from the Molluscous division of the animal kingdom, not because it comes next in the ascending scale of animal life, but because, from its simplicity, it is best suited to our purpose. It is from the class Tunicata; in external appearance they seem but little raised above the Sponges; the greater part of them pass their whole lives in one situation, attached, like the Corals, to the rocks —many of them are associated on one stalk, like the Polypes.

These animals are enveloped in a tough elastic tunic (the analogue of the valves of the Conchifera), and within this is found a muscular coat, consisting of fibres crossing each other in various directions, by which compression may be exercised on the contents of the cavity it surrounds. Two openings penetrate these sacs; one, termed the branchial, admits water to the general cavity, partly for the purpose of aërating the blood, and partly to bring food to the digestive orifice; the other, termed the anal, gives exit to the current which has passed over the respiratory surface, and also to the contents of the intestine and ovaria. These openings are bounded by distinct circular sphincters, with which radiating muscular filaments are intermixed, that extend in longitudinal bands over the surface of the sac.

By means of this apparatus, the animal is capable of diminishing the capacity of the branchial sac, and thus of ejecting, with considerable force, a part of the water it contains; whilst the elasticity of the external

* Observations on the Structure and Functions of the Spinal Cord, by R. D. Grainger, 1837.

† Physiological Inferences to be deduced from the Nervous System of the Invertebrated class of Animals.

tunic spontaneously restores its usual dimensions when the contracting power is inactive. No movements of this kind, however, are commonly employed either for the respiratory process or for the prehension of food.

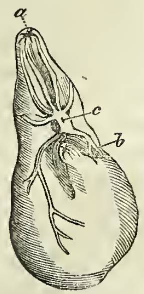
A continuous and equable current of fluid enters the branchial orifice, and is propelled by the anal, without any other visible physical agency than the movement of the cilia, which cover the aërating surfaces. The mouth, or entrance to the stomach, is situated at the entrance of the branchial sac, and is unprovided with any special sensory apparatus; it seems to derive its supplies from the respiratory current alone, and not to depend upon any prehensile movements; but particles unfit to enter it are probably stopped at the branchial orifice. Moreover, as each animal possesses within itself all the organs necessary for the propagation of its race, and as these appear contrived simply for the passive evolution of germs, no powers of active motion are called into exercise by the performance of this function.

So far as the regular vital operations are concerned, therefore, we see indications of voluntary actions in these animals, or even of that kind of respondence to impressions which would lead us to suspect the existence of a connected nervous system. But in the stimultaneous contraction of the whole muscular sac, which is occasionally witnessed, we can scarcely fail to acknowledge the operation of nervous agency.

If one of these animals be touched when its cavity is full of water, a jet of fluid is thrown out to some distance, and sometimes a number are so closely impacted together on the rocks, that the impression given to one, causes it suddenly to retract, which acts also on the one next to it, and so on throughout several of them, and each in contracting throws out a quantity of water. We find, accordingly, on examining into the characters of the nervous system, that it is most simple in its structure and distribution. We have here no repetition of parts, as in the Radiata, and one ganglion serves as the centre of all the actions to which this system ministers. This ganglion lies between the two orifices, and sends filaments towards each, as well as others that ramify upon the muscular sac, to which they seem almost exclusively confined.

In fig. 11 are seen the position of the ganglia and the distribution of its filaments in Ascidia mammillata. The nervous filaments which pass to the branchial orifice, diverge to enclose it, and meet again beyond, so as to form a complete ring.

Fig. 11.



Ascidia mammillata, with nervous system. (Cuvier.) *a.* Branchial orifice. *b.* Anal. *c.* Ganglion, with radiating filaments.

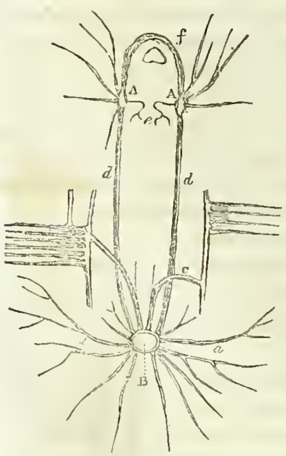
The only organs of special sensation that this animal can be regarded as possessing, are the tentacular filaments which fringe the interior of the branchial orifice. Although nothing is absolutely known of their function, it would not seem improbable that they are susceptible of impressions from substances entering with the respiratory current, which, being propagated at the ganglion, may excite the closure of the sphincters by means of the motor nerves, and thus prevent the admission of injurious bodies. Should this be the case, we can hardly regard the action as of more than a sympathetic character, since the closure of the sphincters in the higher ani-

mals is, in like manner, independent of the impulse of volition, although capable of being influenced by it. It would seem probable, too, that by the same sphincters is regulated the quantity of water which shall enter for the supply of the respiratory and digestive organs, in accordance with their requirements, communicated in like manner through the ganglion, and the ciliary movements would appear to be under the same control (although not so in the higher animals), since in those beings which make use of them in the acquirement of food, such as the common wheel animalcule, they stop and re-commence in such a manner as to prevent the observer from assigning any other cause to their variations.

Passing from this polype-like Mollusk to one a little advanced in the scale of existence, and which, though still chained to the rocks during its whole existence, has some slight power of taking cognizance—we refer to the oyster. It has no locomotive power; almost the only muscular power it enjoys is that by which it closes its shell, its opening being accomplished by the elasticity of a ligamentous hinge. Garner* has stated that distinct, though very simple, organs of vision may be observed on the margin of the mantle. It has long been known to fishermen that the shadow of a boat passing over a bed of oysters will cause them to close their shells: this we can hardly suppose would occur, if they were not supplied with some form of the apparatus of vision.

The sensitive tentacula which guard the alimentary canal are now developed from the true mouth, and two pairs of long flexible tentacula, or palpi, with which the mouth is furnished, seem designed to guard its orifice.

Fig. 12.



Nervous system of oyster. (Garner.) A A. Anterior ganglia. B. Posterior or branchial ganglion inlobed. *a a.* Branches to mouth. *c.* Ditto to gills. *d d.* Connecting trunks. *e.* Transverse filaments, uniting anterior ganglia. *f.* Arch over œsophagus.

The principal ganglion in the oyster (fig. 12, B) is situated by the adductor muscle, between the branchi; it may be called the posterior ganglion; it is the analogue of the ganglion in the creature we have just been examining, (the Ascidia,) and, like it, receives its command from the respiratory surface and the mouth, by the excitor, or afferent nerves, which arise there, and terminate in the ganglion. Like it, it stimulates to contraction the adductor muscle of the shell. Its analogue in man and the Vertebrata generally, is the medulla oblongata, in which the ganglia of the pneumogastric nerves are situated. In addition to this ganglion, there are two small ganglia (A) situated near to the mouth, and the rudimentary organs of sense which guard the alimentary canal. Whatever consciousness this animal enjoys of external nature, is most probably dependent on these ganglia—they are the analogues of the cerebral ganglia in man. The oyster, as we have seen, has no power of locomotion, no in-

* Linnean Transactions, vol. xvii. part iv. p. 485.

struments of progression; but in the same class, the Conchiferæ, or shell-bearing Mollusks, we find some endowed with the power of moving from place to place.

The organ, which is a single one, and is called the foot, is a firm muscular structure; sometimes it is employed in burrowing in mud and sand, and sometimes in executing sudden and rapid motions—true leaps—by which the animal is enabled to change its place with great celerity. The interesting point to us is not the existence of the contractile muscular organ, the foot, by which the motion is effected, as the piston of the steam-engine is by the expansive power of the steam, but the existence of a little bit of vesicular neurine, from which this muscle derives its order to contract and move the animal, and without which neurine the muscle would be powerless, paralyzed, and flabby.

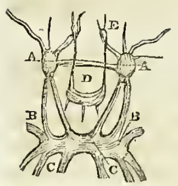
"Wherever the foot exists in the Conchiferæ," says Dr. Carpenter, "we find an additional ganglion in close relation with it, being usually situated at its base, and following its changes of position, as well as corresponding with it in degree of development"—the *pedal* ganglion.

In these Mollusks we have here, then, the cephalic ganglia, or brain, the instrument of consciousness and director of all voluntary movements; the posterior respiratory ganglion, or medulla oblongata, belonging to the excito-motory system, directing the respiratory movements; the pedal ganglion, exciting all the instinctive motions of the foot, the analogue of one segment of the spinal cord in man, or one of the ganglia composing the jointed cord in insects. "It is important to remark," says Dr. Carpenter, "that whilst the pedal ganglion and the respiratory ganglion are always connected with the anterior ganglia, or cerebral ganglia, they are never immediately connected with each other. This would seem to indicate that their functions are distinct, though partly dependent on the influence of the anterior ganglia."

The next class of Mollusca, the Gasteropoda, are known to us in the familiar forms of the snail, the slug, and the limpet. These creatures are much advanced, in their relations to the external world, above the oyster and the conchiferous Mollusks we have just been considering. They enjoy the sense of sight and smell, and having thus the power of distinguishing their food, have a more perfect organ of locomotion to enable them to seek and select it. The union of two individuals is necessary for the reproduction of their species, and we find, in accordance with higher powers, larger and more numerous ganglia for their executing their motions. In some of the species, as in the limpet, for instance, we find these centres of power very distinct, while in others, as in the common slug, there is no anatomical line of distinction, and they are so united, that we can only demonstrate their individuality by referring to the nerves connected with them. This fact has an important bearing on the anatomy of the human body, and teaches us that we must not there look for an anatomical line of demarkation as necessary to decide on the individuality of the ganglia.

We shall find, when we come to the dissection of the medulla oblongata, that there are two ganglia imbedded in its substance, so closely connected, that we can scarcely distinguish them except by

Fig. 13.

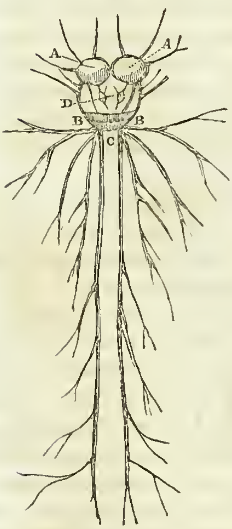


Nervous system of the patella, or limpet. (Garner.) A A. Cephalic ganglia. B B. Branchial. C C. Pedal. D. Pharyngeal. E. Labial.

observing the connection of their nerves. The auditory and pneumogastric ganglia are here referred to. In the patella, or limpet, (see fig. 13,) we observe at the base of the tentacula, and rather anterior, therefore, to the œsophagus, a pair of ganglia (A A), which evidently correspond to the anterior ganglia in the Conchifera, which are connected by a commissural band passing over the œsophagus. These, however, not only send nerves to the tentacula, but are also connected with their eyes which are situated at their base. Beneath the œsophagus, and connected by *two* trunks with each of the cephalic ganglia, we find a broad mass, which, on examination, appears to consist of four lobes placed in a line.

The two inner ones (C C) send nerves to the foot, and are thus analogous to the pedal ganglia of Conchifera. These are connected with the cephalic ganglia by one of the trunks which we observe on each side. Externally to them are the branchial ganglia (B B), which are also connected to the cephalic ganglia by a separate trunk, and with each other by a filament, which may be distinctly traced through the pedal ganglia.*

Fig. 14.



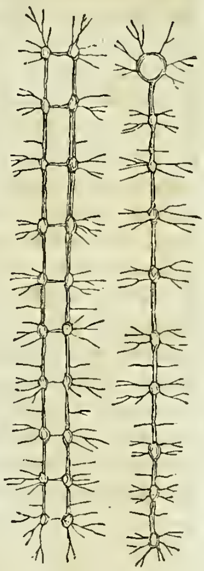
Nervous system of the common slug. (Baly.) A A. Cephalic ganglia. B B. Branchial. C. Pedal. D. Pharyngeal.

" Besides these nerves, we find in the patella, as well as among the Gasteropoda in general, a separate system connected with a very important set of organs, the gustatory and the mandicatory, which are but slightly shadowed out among the Conchifera. In these animals we find the œsophagus dilated at its commencement into a muscular cavity, with a curious rasp-like tongue, which serves to reduce the food, often supported upon cartilages, and sometimes furnished with horny maxillæ. The nerves which supply these do not proceed directly from the cephalic ganglia, but are part of a distinct system, which sends its ramifications along the œsophagus and stomach, and which is occasionally connected with the first by inosculating filaments. In the *Limax ater*, or common slug, we find the cephalic ganglia (A A) united into one large bilobed mass, lying completely above the œsophagus. Another large mass or sub-œsophageal ganglion forms the lower part of the ring, and is connected with the first by two trunks on each side. A little examination will show that this ganglion, like the similar mass in the patella, is composed of two pairs of nerves, having distinct functions. The branches from the outer portion (B) are principally distributed to the respiratory sac, and this will, therefore, be analogous to the outer or branchial portion of the ganglionic mass in the patella, being, like it,

* Garner, *loc. cit.*

connected immediately with the cephalic by a trunk of its own. The inner portion (c) does not send its branches to the *foot* in particular, but to the general muscular surface in which this organ is, as it were, lost, and of which the whole body is concerned, in the progressive movement of the body. Hence, we may fairly regard this as a locomotive ganglion. Two small pharyngeal ganglia are found within the principal ring, connected, as usual, with the cephalic."*

Fig. 15. Fig. 16.



15. From Grant's Outlines of Comparative Anatomy. Nervous System of the *Talitrus Locusta*, or common sandhopper. All the ganglia, eleven in number, are of nearly equal size; the two first, which are the supra-œsophageal, scarcely exceeding in dimensions any of the others. The œsophagus runs between the two first pairs of ganglia.

16. Also from Grant's Outlines, &c., presents the nervous system of the Cymothæa. The œsophageal ring very distinct, but the supra-œsophageal ganglia scarcely developed. The two longitudinal cords, with the pairs of ganglia united, so as to form a uniform cord.

The next specimen of a nervous system to which we shall direct our attention, is taken from the third sub-kingdom, the Homo-Gangliata, or Articulated animals of Cuvier. This is almost as simple in its arrangement as that just referred to; although, in general appearance, it approaches more nearly to that of the higher orders. Fig. 15, taken from Dr. Grant's Outlines of Comparative Anatomy, represents the nervous system of the common sandhopper, or *Talitrus Locusta;* and it will be seen that here, likewise, all the ganglia are of nearly equal size, and nearly at equal distances. The cephalic ganglia are the most anterior, and are a little larger than the rest; the respiratory ganglia are on the side, and detached; and the pedal ganglia, which are numerous, are situated in the separate segments of this jointed body. It will be seen that the cerebral and spinal ganglia, placed on the same side of the mesial line, are connected together by two sets of longitudinal fibres, cerebral columns of volition and sensation. The fibres which connect corresponding ganglia on opposite sides of the mesial line, are analogous to the corpus callosum in the human brain and transverse fibres in the spinal cord. This form of nervous system is seen in the embryos of the higher orders of the Crustacea.

The next stept onwards in the evolution of the nervous system consists in the approach and close connection of the two longitudinal cords, and their accompanying ganglia, or to the concentration of these into apparently a single cord as well as single ganglia. This form is beautifully illustrated by that of the Cymothea (fig. 16).

We have already seen how much the arrangement of the ganglia of the Mollusca confirms Dr. M. Hall's theory of an excito-motory system of nerves. But the recent researches of Mr. Newport into the anatomy of the nervous system of the Myriapoda, completes more perfectly the chain of evidence. Indeed, so satisfactory to my mind are his discoveries of the existence of a distinct set of nerves for the execution of the instinctive movements, that I have no doubt whatever that there is exactly the

* Dr. Carpenter, *op. cit.*

same simple arrangement in the structure of the spinal cord of all vertebrate animals, not excepting man, though at present we have not been able to unravel it with our dissecting knives, or trace all its component fibres with the microscope.

The Myriapoda, of which the common centipede is a familiar example, have several cephalic ganglia situated at the anterior extremity of the body, and connected with the organs of sense, the eyes, antennæ, &c. Mr. Newport states,* that in the embryo of *Necroph. leophagus* (Geophilus), *longicornis* (Leach), at the moment of bursting its shell, the brain is composed of *four* double ganglia, the centres of a corresponding number of segments, which are then becoming aggregated together, so as to form this single movable portion of the head of the perfect animal; so that the brain of the Myriapoda, and probably of all the higher Articulata, is in reality composed of at least four pairs of ganglia. The first ganglia being devoted to the nerves of the antennæ, may, I think, be regarded as analogous to those which we shall see in the Vertebrata devoted to the olfactory nerves. The next mass in the perfect insect, as in the embryo, I conclude consists of two pairs, composed of the hemispherical or volitional ganglion, and the optic ganglion. This view of the homology of the second pair of ganglia will be better understood by the student when we come to the brain of the Fish. It is very clear that it is not solely the optic ganglion, in as much as it exists even when the organs of vision are entirely wanting, as in the whole of an extensive family of Chilognatha—the *Polydesmidæ*. The next pair supply the mandibles and maxillæ. Emanating from these ganglia, there are nervous cords, like the crura cerebri in man, which run down and enter into the composition of the spinal cord, similar to those we have just observed in the *Talitrus*. These, he considers, are the conductors of volition and sensation, and give off minute branches at each segment of the body to each of the spinal nerves: as the powers of volition and perception are very low, so are these instruments very minute. The spinal cord, as a whole, is very large in proportion to the brain, because its ganglia and their own especial nerves, constituting the excito-motory system, or system of instinctive and unconscious movements, are large and predominant.

The ganglia of organic life, the analogues of the so-called sympathetic nerve in man, are also very fully developed; distributed in a great part to the salivary glands.

The visceral ganglia in Iulus are of most extraordinary size, being nearly half as large as the brain itself. There are four on each side the œsophagus, closely connected in one series, extended along the œsophagus as far as the middle of the first or pro-thoracic segments, giving off branches of nerves to the immense salivary glands, to the œsophagus itself, and surrounding structures. They exhibit the appearance of gray nervous matter inclosed in a distinct theca.

They communicate with the vagus nerve, which, after passing beneath the brain, forms a minute ganglion immediately behind it, which is also connected to the lateral ganglia by a very minute branch on either side. It then passes along the œsophagus, and forms the second larger rounded

* Phil. Trans., 1843, p. 248.

ganglion first mentioned as connected to the last of the lateral ganglia. After this it continues its course backwards, half way along the œsophagus, and then divides into two branches, which are given off, as in insects, to the posterior part of this organ, and to the cardiac extremity of the stomach.

One of the most interesting circumstances connected with the development of the nervous system in Iulus, is the relative size of the brain as compared with that of these ganglia of the viscera. "In these inferior Myriapoda," says Mr. Newport, "in which the power of locomotion is distributed equally to every segment of the body, the brain itself forms but a small proportion of the whole nervous system, and the faculties of sense are less perfect than in insects; while the nerves of organic life, and their ganglia, are nearly equal in volume (as in Iulus) to the whole brain, the organ of volition. The very reverse of this is the case in insects."

"In those in which the faculties of sense, more especially of vision and smell, and the power of voluntary motion, are carried to their greatest extent—as in Volant insects, the gregarious Hymenoptera, Neuroptera, and Lepidoptera—the volume of brain bears a much larger proportion to the rest of the nervous system, and the ganglia of organic life a smaller. This is more especially the case in the perfect insect, in which the volume of the brain is not merely relatively, but actually, increased in size during the changes from the larva to the perfect state; thus leading to the inference, that the importance of the visceral nerves is gradually diminished in proportion as those of active volition and active existence become augmented."*

"The spinal cord in the Myriapoda is extended from its commencement in the crura of the brain, and medulla oblongata, or first sub-œsophageal ganglion, to the antepenultimate segment of the body, and is almost uniform in size throughout its whole length. It is slightly larger at its anterior, and smaller at its posterior extremity, than in the middle part of its course. In *Iulus terrestris* it has ninety-six very minute ganglionic enlargements situated entirely on the under surface of the cord, and so closely approximated together as not to be observable except on very close inspection. Each of these enlargements gives off two pairs of nerves, one of which, on the under surface, is given to the legs, and the other, on the lateral and superior surface, to the sides of the body; so that the whole number of nervous trunks from the cord, including those from the medulla oblongata, is ninety-four pairs to the head and sides of the body, and ninety-two pairs to the legs, making in the whole 186 pairs, or 372 nervous trunks from the cord, exclusive of those which belong more immediately to the brain. Each enlargement of the cord gives off at its upper and lateral surface a single nervous trunk, which passes outwards some distance as a single nerve, but which in reality includes two distinct sets of nerves, that separate as principal trunks at the inner side of the great longitudinal series of abdominal muscles."*

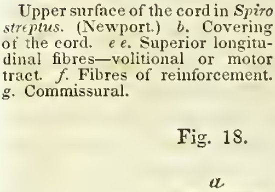
The anterior of these trunks is the analogue of the respiratory nerves of insects, and passes across the upper layer of these muscles, on their visceral surface, giving off to them many minute branches.

* Op. cit.

The *Structure of the Cord* is thus described by Mr. Newport: "The formation of the great abdominal cord in the Iulidæ, by the lateral approximation of two distinct portions, is indicated on its upper surface by a slight median sulcus, and on its under surface by a slight longitudinal division between the two approximate ganglia that form each of its enlargements. Each of these lateral divisions of the cord in Iulus, as formerly shown in the Scolopendra and other Articulata, is a compound structure, formed of two distinct series of longitudinal series or columns of fibres, which, notwithstanding the different explanation that has been given of their function since I had the honor of first describing them to the Royal Society, are quite distinct from each other, although closely approximated together. By the aid of means superior to those formerly employed in my investigations, I now find that the abdominal cord contains other structures besides those already described."

"In my former communication to the Royal Society, I indicated the existence of fibres that run transversely through the ganglia of the cord in the larva of the common butterfly, and similar structures have since been shown by Dr. Carpenter in other Articulata, and applied to explain some of the reflex phenomena of the nervous system, in accordance with the theory promulgated by Dr. M. Hall. But besides these two sets of longitudinal fibres, and the series that pass transversely through the ganglia, there are other structures in the cord that have hitherto been entirely overlooked. These are the fibres that run longitudinally, in part of their course, at the sides of the cord, and enter into composition of all the nerves from the ganglia. These fibres I shall designate *the fibres of reinforcement of the cord*."—(Fig. 17, *f*.)

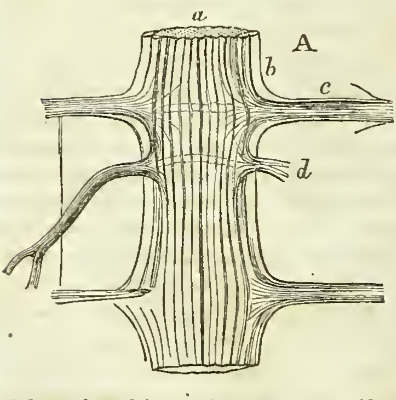
Fig. 17.



Upper surface of the cord in *Spiro streptus*. (Newport.) *b*. Covering of the cord. *e e*. Superior longitudinal fibres—volitional or motor tract. *f*. Fibres of reinforcement. *g*. Commissural.

"The superior longitudinal set of fibres of the cord, which I formerly described as the motor tract, and to which the function of volition seems still to be accorded by Valentin, Carpenter, and Baly, is extended in Iulus, as in other Articulata, as a separate fasciculus along the upper surface of the cord; but in these Myriapoda it is much narrower in proportion to the whole width of the cord than in insects. The fact is interesting in reference to its presumed function. On a cursory inspection, it does not appear to give off any branches, but seems to pursue its course uninterruptedly along the whole length of the cord. It does not indeed give

Fig. 18.



Under surface of the cord in *Spiro streptus*. (Newport.) *a*. Inferior longitudinal fibres—sensory tract. *b*. Fibres of reinforcement. *c*. Nerves. *d*. Commissural fibres.

off filaments to the nerves from a ganglion immediately opposite their origin, while passing over that ganglion, but immediately it has passed one ganglion, it gives off the filaments that proceed to the nerves from the next ganglion These filaments seem almost immediately to join with others that belong to the sides of the cord, and pass out with them into the nerve from the next ganglion along its anterior surface."

"This is almost precisely the manner in which the filaments from the aganglionic column in the Crustacea are united with those from the ganglionic, as formerly shown in my description of the nerves in that class, when the existence of the lateral fibres of the cord was unknown to me. The inferior longitudinal or ganglionic set of fibres (fig. 18, *a*) of the cord, affords many interesting considerations. It is placed, exactly as in insects, on the under surface, but, like the upper series, it is narrower than the whole cord, of which it forms a part. It is formed of a longitudinal series of fibres, like the upper track, beneath which it is placed, and from which it is divided by some of the fibres that pass transversely through the cord, and which enter into the composition of the nerves from the ganglion on either side. It appears also to receive filaments from the upper series, and perhaps others are sent from it to the upper, thus decussating each other in the middle substance of the cord when these two longitudinal series are in close apposition; since it is almost impossible, even in the large nervous cord of Scolopendra, to separate the two tracts from each other, although their distinctness is evinced in their relative size and longitudinal lines of separation."

"But there is one fact of great interest in regard to these ganglionic series of fibres. Almost the whole of the fibres of which it is composed are traceable in the Iulidæ directly through each enlargement of the cord, which they mainly assist to form. At the anterior part of each enlargement, the diameter of each fibre, or fasciculus of fibres, appears to be slightly increased, and its structure becomes more soft and delicate. While passing through these ganglionic enlargements, occasioned chiefly by their own increased diameter, the fibres take a slightly-curved direction outwards, and then inwards, but are reduced to their original size, and assume the longitudinal direction, on again forming the ganglionic portion of this tract of the cord. This structure of the fibres is well seen in Iulidæ and Polydesmidæ, as I shall hereafter again have occasion to refer to more especially, with reference to the true structure of ganglia. The fibres are traceable most distinctly in the Iulidæ (fig. 19, *i*).

"These are the structures to which I formerly assigned the function of voluntary motion and sensation, and to which I am still inclined to believe they minister, since the fibres of which both are composed are traceable to the crura of the brain. Whether these functions are restricted separately to the two structures, as I first imagined, the one to the upper, the other to the inferior series, or whether they are administered to conjointly by both, through an interchange of fibres, it is almost impossible to determine by any decisive experiment on these animals, although the structures themselves are distinct. But in the absence of experimental proof, there are circumstances connected with the distribution of the nerves to the extremities which seem to indicate that these low forms of Articulata are endowed with a power of sensation and

feeling far beyond what has of late been adjudged to them by some physiologists."

"In some of the gigantic Spirostrepti and Spiroboli the legs are adapted for climbing up the trunks and branches of trees, by the under surface of the first and second basilar joints of the tarsi being developed into a soft cushion or pad, as in some insects; and to these limbs, I have found the nervous fibres more extensively distributed than to any other, —a fact most strictly analogous to that of the distribution of nerves in the tactile parts of the limbs of Vertebrata."

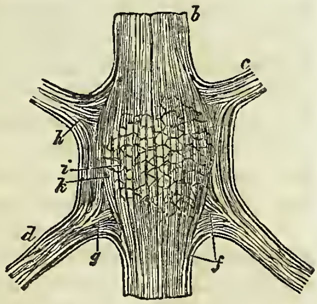
"Those fibres of the cord which seem to be independent of the sets just described, and which do not appear to have any direct communication with the great seat of sensation and volition—the brain—are of two kinds, which may justly be regarded as involuntary in their functions. The first of these are the commissural fibres, (figs. 17, *g*; 18, *d*,) which pass through the ganglia; and the second are those which have hitherto been undescribed, and form the sides of the cord (*f*) in the interspace between the ganglia, or between certain nerves distributed from them—the fibres of reinforcement of the cord."

"The fibres of reinforcement of the cord form the lateral portions of the whole nervous cord of the body, and enter into the composition of all the nerves. They constitute, as it were, circles of nervous communication between two nerves that originate from the cord at a greater or less distance; and form part of the cord in the interval between these nerves, and bear the same relation to the segments, individually, which the cord itself does to the whole body. They form a part of the nervous trunks which come off from its upper, or aganglionic tract, as well as of those which proceed from the ganglionic enlargements in the lower, and in each instance they bound the posterior side of one nerve and the anterior of another, to which they proceed along the side of the cord, forming in the interspace a part of its structure. Each fibre may thus be traced from its peripheral distributions, in the structures of the external surface of the body, inwards along the course of the nerves, on their posterior surface to the cord, where its direction is altered from that of the nerve transversely inwards, to that of the cord on which it is reflected, and passes longitudinally backward; thus forming a part of its external surface until it arrives at the root of the nerve, to which it is to be distributed, and along which it again passes transversely outwards, bounding the anterior surface of the nerve to its distribution on the lateral surface of the body. These fibres of reinforcement form a large proportion of the whole cord, and enter into the composition of the upper anterior, and part of the inferior, surface of the root of every nerve in their course inwards to the cord; and of its posterior and inferior surface on their again proceeding outwards. In this manner these fibres of reinforcement connect all the nerves of the cord on one side of the body, as the corresponding fibres do those on the opposite side. They form, as it were, double, triple, or quadruple circles, one within the other. Thus the fibres that pass inwards along one nerve may proceed along the cord to pass outwards again on the front of a second, a third, or a fourth, linking the segments in one continued series of nervous communications independent of the brain. But these communications exist

only between nerves on the same side of the body, and not between those on the opposite. The commissure nerves connect the opposite sides of each individual segment, as those of reinforcement do the same sides of two separate segments."

"Every nerve from a ganglionic enlargement of the cord is thus composed of four sets of fibres, an upper and an under one, which communicate with the cephalic ganglia; a transverse or commissural, that communicate only with the corresponding nerves on the opposite side of the body; and a lateral set that communicate only with the nerves from a ganglionic enlargement on the same side of the body, and form part of the cord in the interspace between the roots of the nerves. It is by the successive additions of these lateral portions of the cord that its size is maintained almost uniformly throughout its whole length in the elongated bodies of the Myriapoda. On examining the cord very closely, I have reason to believe that the upper and inferior sets of longitudinal fibres, the ganglionic and the aganglionic, are somewhat smaller at their posterior than at their anterior extremity, a circumstance readily understood in the fact that successive series of filaments are given off from them at each distribution of nerves from the ganglionic enlargements, while the relative size of the lateral portions of the cord appears to be greater in the posterior than in the anterior. On this account I have named these lateral fibres, fibres of reinforcement of the cord. In regard to the identification of these fibres, it may be well further to state that their separate existence is indicated chiefly at the postero-lateral margin of the ganglia, (fig. 19, *f*,) where they are seen to form part of the nerves and cord without passing upwards to the brain. In other parts of their course they are not distinguishable by color, and very rarely by any longitudinal line of separation, from the fibres which form the inferior longitudinal series, or portion of the cord to which they are approximated; but from which they are believed to be distinct, from the fact that they do not descend with them to the brain."

Fig. 19.



Ganglion and nerves of the spinal cord of *Polydesmus maculatus.* (Newport.) *b.* Covering of the cord. *c.* Nerves to muscles. *d.* Posterior nerves. *f k.* Fibres of reinforcement. *g h.* Commissural fibres. *i.* Fibres of the inferior or ganglionic tract passing between the ganglionic vesicles (*k*).

"Their function must be regarded only as reflex, entirely independent of sensation, but capable of being excited into action by external causes. The existence of these lateral fibres in the cord may now fully explain the reflected movement of parts anterior or posterior to an irritated limb on the same side of the body, as the commissural ones do the movements of the parts on the side opposite to that which is irritated. The presence of these fibres in the cord of insects I had long suspected from the curved direction of the fibres that formed the ganglia, and from that of the origin of the nerves, from the aganglionic tract, as figured in my former paper; and although I had communicated this opinion to a friend

several years ago, I have never, until recently, been able to satisfy myself of its correctness."

"This uncertainty of the existence of any structure in the cord that seemed sufficient to explain the reflected movements on the same side of the body, independent of the brain and the nerves of volition and sensation, long obliged me to withhold my assent now received respecting these phenomena. Although the fibres that pass transversely through ganglia might explain the fact produced on one side of the body, by the irritation of a corresponding part on the other, there seemed no anatomical structure to account for the movements of distant parts, anterior or posterior to a given point, if the doctrine long received, that each fibre was endowed with but one special function, were correct."

"Now, therefore, that we find an anatomical structure in the cord that seems to account for these phenomena, I ought, in justice, to state that Dr. Hall,—to whom is due the high credit of collecting, comparing, and arranging in one system, numerous facts connected with the reflected movements of animals, as observed by Whytt, Blane, and others, and also by himself,—adopting the principle established by our distinguished countryman, Sir Charles Bell, that every nervous fibre is continued unbroken, from its origin to its termination, and is capable only of administering to one special function,—conceived the necessity of the existence of special nerves for the reflected movements, and that at the period when I was engaged with Dr. Hall in his experiments on this subject, in 1833, he requested me to examine the cord in the hedgehog, to ascertain the correctness of his opinion. This examination was not made, because at that period I differed from him in attributing the reflected movements to the agency of another part of the nervous system."

"Now that the views of Dr. Hall seem proved to be correct, I am desirous of adding this testimony of the acuteness and perception of one who has done much for physiological science."

Professor Owen's testimony on this subject is most important and satisfactory.* After describing the nervous system of the Crustacea, he says: "Three principal divisions of the nervous system may be defined, according to the views which I entertain of their functions. Thus, admitting from analogy, that the supra-œsophageal ganglionic centre is that in which true sensation and volition reside, then those nervous filaments which are exclusively connected therewith, and some of which would seem to extend the whole length of the animal along the dorsal aspect of the ganglionic columns, would form with their ganglionic centre the true sensori-volitional system, whilst any other ganglions superadded to the abdominal columns, with the nervous filaments terminating in or originating from them, would constitute the system for the automatic reception and reflection of stimuli. The stomato-gastric nerves, connected partly with the brain, and partly with the œsophageal columns, will form a third system, analogous to the great sympathetic or organic nerves of the Vertebrata. In these views I coincide with that ingenious physiologist, Dr. Carpenter, and shall feel happy if their accuracy and soundness have received any additional proof from the

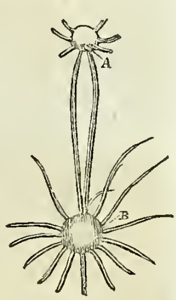
* Owen's Lectures, vol. i. p. 173.

facts of Comparative Anatomy, which, in the Hunterian Lectures of 1842, were for the first time brought to bear upon this interesting problem."

From these most interesting discoveries of Mr. Newport, and the important physiological deductions, which are drawn so justly from them, let us turn to a form of nervous system which will serve to instruct us how wonderfully Nature varies her resources according to the task she has to execute, always maintaining real simplicity amidst an almost boundless variety; teaching us, also, that the shape alone, and general outline of the component parts of a nervous system in the lower animals, will guide us very imperfectly to its analogues in man, and that we must search deeper for a clue to unravel the structure of the human brain. Instead of simply directing our attention to the shape of the ganglia, we must rather consider how far the distribution of the nerves, which, we believe, to be the conductors of the power generated by the ganglia or centres, corresponds in the specimens we select for illustration. Guided by this principle, we can always discriminate the masses of neurine or optic ganglia, in which the optic nerves terminate in each individual where optic nerves exist, and so of all the other centres or ganglia, which, in the higher tribes of animals, especially, are found so closely united that the whole mass appears but as one, when it is called the brain. On the same principle, in the specimen which we shall next attend to, we must observe that the collection of neurine from which the nerves of the extremities arise, though wholly dissimilar in shape, is analogous to the dotted spinal cord of the Myriapoda and the smooth cord of the Vertebrata. In the common crab, the neurine, which, in the last described species, was deposited so as to form a chain of ganglia spread along the surface of the abdomen, is collected into only two masses, the one situated in the head, and the other in the thorax.

The anterior of these ganglia, the *supra-œsophageal*, or brain, is small as compared with the posterior; for the organs of sense, whose nerves terminate in this centre of power, are as yet but imperfectly developed, while the muscular system, deriving its supply almost entirely from the posterior or thoracic ganglion, is large and powerful.

Fig. 20.



Nervous system of the crab. A. Cerebral ganglia. B. Pedal ganglia, or spinal cord.

The anterior ganglion is connected with the posterior by two slender nervous threads, volitional and sensory filaments, which, passing on each side of the œsophagus, form with the ganglia the same œsophageal ring we have before observed.

Advancing from this, one of the most simple forms of the nervous system in the Crustacea, we next meet, in some of the insect tribe, with a very decided step towards the concentration of the higher orders; for the nervous ring round the commencement of the alimentary canal receives additional ganglia on its superior surface, until the whole mass formed by the union of these nervous centres, or instruments of consciousness, assumes the appearance, and seems entitled to the appellation, of a *brain*.

The intimate connection and apparent dependence of the organs of sense, as the eye, &c., upon those appropriate masses of cineritious or pulpy neurine in which their nerves terminate, and to which, therefore, we suppose the impressions of light, &c., received on their peripheral expansions transmitted, in order to become perceived by the animal, is beautifully illustrated by the various alterations, which take place in the nervous system of the moth, as it advances from the caterpillar to the perfect insect, or imago.

It would be inconsistent with my purpose, if I were to expect the

Fig. 21.

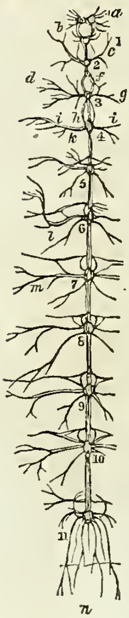


Fig. 22.

Fig. 23.

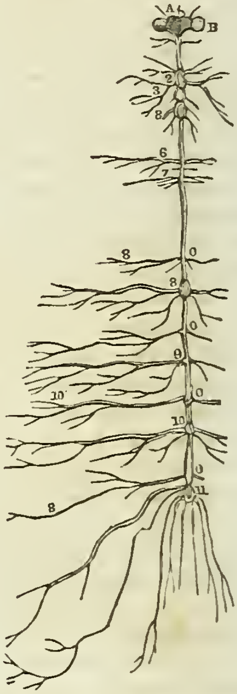


Fig. 21.—Nervous system of the larva of *Sphinx Ligustri* after it has acquired its full growth, and about two days previously to its change to the pupa state. (Newport.) *a.* The supposed brain, or anterior nodules of the cord. 1. The first ganglion situated in the head, or first segment beneath the nodules. 2, 3, 4, 5. Ganglia of the trunk supplying nerves to the legs and wings. 6, 7, 8, 9, 10, 11. Ganglia of the abdomen. *b.* Nerves to the mandibles. *c.* Second pair from the second ganglion, given to the muscles of the neck. *d.* Third pair, given to the first pair of legs. *f.* Nerves for the first pair of wings, with two roots; one from the cord, and one from the third ganglion, and connected also with the transverse plexus. *g.* Second pair of nerves from the third ganglion, given to the second pair of legs. *h.* Transverse plexus from the third ganglion. *i i.* Nerves for the second pair of wings, originating, like the first, from two roots, one from the cord, and one from the fourth ganglion, and connected also with branches from the transverse plexus from the third. *k.* Second pair from the fourth ganglion, given to third pair of legs. *l.* Nerves from the fifth ganglion, which, in the pupa, are those given to the posterior muscles of the trunk. *m.* Nerves from the sixth ganglion, which, in the pupa, are those of the anterior muscles of the abdomen. *n.* The last pair of nerves from the terminal ganglion, given to the rectum and organs of generation.

Fig. 22.—Nervous system of the *Sphinx Ligustri*, thirty days after changing to the pupa state. (From Newport.) This drawing exhibits the abdominal cords in their shortened state, with only five instead of seven ganglia, the fifth and sixth having passed onwards and become continuous with the fourth. The cords in the trunk and the nerves to the wings are enlarged; and those nerves which in the larva arose in the second ganglion, are also enlarged, and now originate from the cords, while the first ganglion has advanced very near to the superior lobes of the brain. The terminal ganglion exhibits a very peculiar structure.

Fig. 23.—Nervous system of the perfect insect *Sphinx Ligustri*. A. Cerebral ganglia. B. Optic nerves. The figures refer to the number of the ganglia. *o o o o.* Respiratory nerves.

student to follow the description of the various nerves connected with these ganglia, in the present state of his knowledge; nor do I conceive that such a proceeding would diminish his difficulties in reference to the study of the human brain. It is, however, an important fact in relation to the function of neurine, that the brain of the perfect insect or imago is very much larger than that of the caterpillar. The butterfly is endowed with very perfect organs of sense and locomotive powers, which enable it to roam from flower to flower, and perform the important office of reproduction: its organs of vision are large and complicated. The poor caterpillar has comparatively imperfect organs of sense, and has but one office to fulfil, namely, to procure food and convert it into nourishment for the development of larger nervous centres, and a more highly endowed animal. By reference to these wood-cuts, the student will observe, in fig. 21, the two little cerebral ganglia (*a*), scarcely larger than the infra-œsophageal or respiratory (1).

Without following out each different stage in the gradually progressive change which the nervous system of the larva and pupa undergoes previous to its attaining its full development in the imago, he may, after observing the relative size in the larva (fig. 14), and the gradual concentration and aggregation of the spinal or locomotive ganglia in the pupa (fig. 22), turn to fig. 23, when he will see it in the imago or perfect insect. The cerebral ganglia are now extended transversely, and form, with the first sub-œsophageal ganglion, and the enlarged crura which connect them, one continuous mass around the œsophagus and anterior part of the dorsal vessel. The second ganglion has entirely shifted its position, and receded towards the middle of the thorax, and has coalesced with the third, which has entirely disappeared, and seems to have joined in part with both the second and fourth, and the intervening cords. This aggregation of ganglia and cords is situated in the middle of the thorax, and supplies all the muscles in that part of the body. The longitudinal cords are continued from the hinder part of the fifth ganglion, and just before leaving the thorax to enter the abdomen, they give off the nerves which formerly belonged to the sixth ganglion, which is now entirely obliterated. The cords then descend into the abdomen, and immediately give off the nerves that belong to the seventh ganglion, which, with part of the cord that existed between the sixth and seventh ganglia, is also obliterated. The cords are then continued in a direct line along the abdomen, the 8th, 9th, 10th and 11th ganglia being situated as in the previous stages. Such is the state of the nervous system of the perfect insect.

The centre of the nervous system of the sphinx in its perfect condition is covered in by a new structure, and does not lie, as in the larva, in the open cavity of the thorax.

Our attention having been directed, in the instance of the moth, to the progressive development of the encephalon from the larva to the imago, and to the striking increase in the size, and greater complexity in the form, of the nervous system when the animal becomes fitted to receive impressions from the objects which surround it, which it does through the medium of especial organs of sense, and not by the whole surface of the body, as in the Medusæ and lowest forms of animal existence, we

are prepared to appreciate similar changes in some of the higher Mollusca, and to inquire how far the nervous organization of these creatures will countenance the opinion that there is an intimate relation between the bulk of cineritious neurine in which each individual nerve of sense

Fig. 24.

Nervous system of the Pearly Nautilus. (Owen.) The head and anterior muscular part of the body of the Pearly Nautilus (*Nautilus Pompilius*, Linn.), laid open from above or behind, and the nervous system displayed. *a.* The cut edges of the musculo-ligamentous disc which covers the head. B B. The open ends of the digitations. C. Four of the digital tentacles exposed by laying open the canals in which they are lodged. *d d.* The anterior ophthalmic tentacles similarly exposed at their origins. *e.* The left external labial process. (The corresponding one on the right side has been removed.) *f.* The external labial tentacles. G. The internal labial tentacles. *h.* The olfactory laminæ. *i.* The internal labial tentacles of the left side similarly exposed. *k.* The origin, on the left side, of the muscle which protrudes the jaws. *l.* The inner concave surface of the great shell-muscles. *m.* The termination of the right muscle. *n.* Orifices by which the vena cava communicates with the abdominal cavity. *o.* The eye laid open. *p.* The pedicle. *q.* The pupil seen from within. *r.* The cut-edge of the sclerotic. *s.* The retina. *t.* The dark pigment deposited on its anterior surface, and lining the cavity of the globe. 1. The supra-œsophageal ganglion or brain. It is in the nautilus in the form of a simple cord or commissure, to the extremities of which are connected (2 2) the anterior subœsophageal ganglia. 3 3. The optic ganglia. 4 4. The posterior sub-œsophageal ganglia. 5. Buccal and pharyngeal nerves. 6 6. The nerves which supply the digital tentacles, and in the cuttle-fish the acetabuliferous arms. 7 7. The nerves passing to 8 8, the internal labial ganglions. 9 9. The branches to the internal labial tentacles. 10 10. The nerves supplying the olfactory laminæ. 11 11. The nerves which supply the infundibulum. 12 12. The nerves of the external labial tentacula. 13. The nerves of the great muscles of attachment. 14. The nerves corresponding to the par vagum. 15. The branchial nerves. 16. The ganglions communicating with the visceral or sympathetic nerves, and supplying the heart, venous follicles, and abdominal viscera.

terminates, and the perfection of the organ of sense from which that nerve arises.

However much we may have had reason to be gratified with the evidence which our investigations into the development of the moth has afforded us of the existence of such a relationship, we shall be even more delighted with the clear proof of the universality of such a law, which one very interesting class of the Molluscous division of the animal kingdom in particular has lately yielded to the physiologist: I allude to the admirable Memoir of Mr. Owen on the Pearly Nautilus,* and to his account of the structure of the cuttle-fish, published a few months ago;† and whilst I do so, I gladly express my thanks to this philosophical anatomist, for several kind and valuable hints during the progress of this work.

We shall first consider the relations that exist between the perfection of the organs of the senses, and the bulk and complexity of the central portions of the nervous system in the Pearly Nautilus, and afterwards in the Cuttle-fish, in which they will be found to be still more strikingly displayed than in the former.

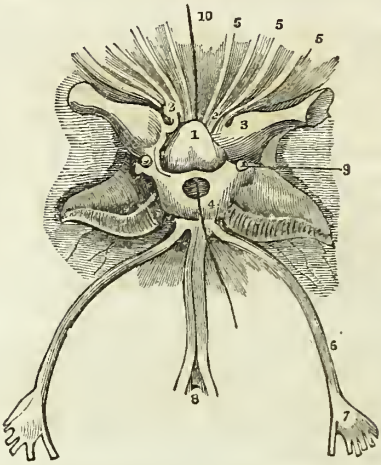
"The brain or supra-œsophageal mass in the Nautilus (fig. 24) consists of a transverse cord-like ganglion, from the ends of which three nervous trunks are continued on each side. The anterior pair pass downwards and forwards by the sides of the œsophagus to unite below it, forming a ganglion on either side, which supply the digital processes and tentacles, and give off nerves to the organ of smell and the funnel. The middle and superior trunks dilate into the optic ganglia; the retina, which terminates that of the left side, is shown. The posterior cords surround the œsophagus in a manner analogous to the anterior pair, forming also two ganglionic swellings, from which the nerves of the great shell-muscle and those of the viscera are given off; the latter nerves are of small size, and are continued down by the side of the great perforated vein, and are analogous in their distribution to the sympathetic nerves and par vagum."

The organization of the *Sepia officinalis*, or cuttle-fish (fig. 25), is peculiarly interesting, not only from the fact that it offers to our notice the first appearance of an internal skeleton, an apparatus, which, in the Vertebrata, is constructed in intimate relationship with the nervous system, and is often entirely appropriated to its protection; but we find this rudimentary skeleton supporting a central ganglion of unusual dimensions, and a nervous system very highly developed in many of its parts. In its general arrangement, however, the nervous system differs but little except in the quantity of neurine composing the cerebral ganglia from that of the Nautilus, as will be apparent by turning to fig. 18, in which the differences between them are exhibited and made apparent to the eye. In fig. 18 the bristle is placed in the situation of the œsophagus, around which the nervous masses are aggregated.

* Memoir on the Pearly Nautilus (*Nautilus Pompilius*, Linn.), by Richard Owen, Esq.; published by direction of the Royal College of Surgeons in London, 1832.

† Descriptive and Illustrated Catalogue of the Physiological Series of Comparative Anatomy contained in the Museum of the Royal College of Surgeons in London; Vol. III. Part I. Nervous System and Organs of Sense, 1835. From one or other of these publications the following particulars, and the figures 24 & 25, are entirely derived.

Fig. 25.



The brain and origins of the principal nerves of a Cuttle-fish (*Sepia officinalis*, Linn.). "The bristle (10) is placed in the situation of the œsophagus, around which the nervous masses are aggregated. The brain and optic or reniform ganglions are here developed in accordance with the more complex organ of vision, and the more extensive locomotive faculties of this higher-organized Cephalopod. A small spherical body, probably analogous to the corpus geniculatum, is appended to the peduncle of the optic ganglion on either side.

"As the supra-œsophageal cerebral mass is principally in communication with, and is developed to receive the impressions transferred by, the optic nerves, it must be considered as analogous to the bigeminal bodies in the brain of Vertebrata, which parts are first developed in all the higher classes, and from their constancy and magnitude in the cold-blooded Vertebrata, are evidently among the most important parts of the cerebral organ. The medulla oblongata, from which the auditory and respiratory nerves are given off, is in the cuttle-fish situated below the œsophagus: *p*. The cut surface of the cartilaginous cranium. The ganglion stellatum from which the nerves pass to the soft vascular and sensitive exterual covering of the *Sepia*."

1. The brain, corresponding to the central commissure of the Nautilus. 2 2. The anterior sub-œsophageal mass, or *pes anserinus*, giving off (5 5) the nerves to the arms. 3 3. The great reniform, or ophthalmic ganglions. 4 4. The posterior sub-œsophageal mass giving off (6 6) the nerves to the cloak; and (8) the nerves to the viscera. 7 7. The ganglion stellatum. 9 9. Two small spherical bodies attached to the pedicles of the ganglions. 10. Bristle.

"As the supra-œsophageal cerebral mass," says Mr. Owen, "is principally in communication with, and is developed to receive the impressions transferred by, the optic nerves, it must be considered as analogous to the bigeminal bodies in the brain of Vertebrata; which parts are first developed in all the higher classes, and from their constancy and magnitude in the cold-blooded Vertebrata, are evidently among the most important parts of the cerebral organ." A small spherical body, considered by Mr. Owen as probably analogous to the corpus geniculatum, is appended to the peduncle of the optic ganglion on either side.

"The medulla oblongata, from which the auditory and respiratory nerves are given off, is, in the cuttle-fish, situated below the œsophagus.

"The anterior sub-œsophageal ganglia give off nerves to the brachial and labial processes; the posterior sub-œsophageal ganglia send off laterally the large nerves which pass outward to the mantle, and then form on either side the great ganglion, which, from the radiated distribution of its filaments, is termed ganglion stellatum." In addition to these there are a pair of nerves which, like those in the Aplysia, descend to the region of the heart, and there form a plexus for the supply of the organs of digestion and circulation, and exhibit a very perfect analogy to the cardiac and solar plexuses of the sympathetic nerve in man.

This very general review of the nervous system in these two members of the cephalopodous class of Mollusca shows us, in the first place, that the supra-œsophageal ganglion in the Nautilus has no cranial cavity constructed for its protection, and that instead of being a distinct rounded mass, as in the Cuttle-fish, it seems little more than a rounded cord or commissure connecting the ophthalmic ganglia, and placed transversely to the œsophagus. These facts by themselves would be of little value as affording data for reasoning on the offices and relations of the nervous system, did we not discover this comparative imperfection in the structure of their brain corresponding with imperfect development of the organs of locomotion and sensation generally. The peculiarities in the structure of the Nautilus are in complete correspondence with this principle. "The eye," observes Mr. Owen, "is far from presenting those complexities of structure that render it so remarkable an organ in Dibranciate Cephalopods. Indeed, it here appears to be reduced to the simplest condition that the organ of vision can assume, without departing altogether from the type which prevails throughout the higher classes. For although the light is admitted by a single orifice into a globular cavity or *camera obscura*, and a nerve of ample size is appropriated to receive the impression, yet the parts which regulate the admission and modify the direction of the impinging rays are entirely deficient." This state of the eye appears to be in harmony with the habits and aptitudes of the animal so far as they are known. On the other hand, the superior locomotive powers of the cuttle-fish demanding more perfect vision, we find not merely the eye more complex and perfect in its construction, but the "centre to which the impressions of the optic nerve are referred, more highly developed."

In fact, as Mr. Owen observes, (p. 51), "The inferiority of the more intellectual senses, sight and hearing, is in correspondence with the simplicity of the brain. If, as I believe, a distinct organ for the latter sense is altogether wanting, the Pearly Nautilus exhibits, in this respect, an obvious approximation to the inferior Mollusks.

"As the Pearly Nautilus, like the latter group of Mollusks, is also attached to a heavy shell, and participates with them in the deprivation of the locomotive instruments of the Cephalopods, we may thence deduce the more immediate principle of their reciprocal inferiority with respect to the visual organ; for what would it avail an animal to discern distant objects, which could neither overtake them if necessary for food, nor avoid them if inimical to its existence?"

The following difference in the distribution of the nerves of the *Nautilus Pompilius* and *Sepia officinalis* is also highly instructive.

"In those Cephalopods, whose shells are rudimentary and internal, and whose bodies are enveloped in a naked, and, as we may suppose, sensible mantle, the nerves which supply that part radiate from a ganglion, which, as in the posterior roots of the spinal nerves in the Vertebrata, is interposed on the cord which brings them into communication with the central mass. In the Nautilus, on the contrary, whose body is incased in an insensible calcareous covering, the analogous nerves are wholly expanded on the largely-developed muscles which attach the shell to the body; and these nerves, like the motor filaments of the

spinal nerves, pass into the muscles directly from the brain without the interposition of any such ganglion."*

The nervous system in the Myeloncephala, or vertebrated class of animals, which derive their name from that beautiful piece of mechanism constructed expressly for the purpose of protecting the central portions of this system, will next engage our attention. This subkingdom includes Fishes, Amphibious animals, Birds, Reptiles, and the Mammalia.

In these animals the whole skeleton is developed in relation to the nervous system; and we find, as might be expected, the axis or central portions become, by an increase of bulk and gradual concentration of parts, more decidedly elevated above the peripheral. The supra-œsophageal ganglion now having an appropriate organ, the cranium or skull, for its protection, uniformly passes by the name of brain; while the remaining ganglia with their commissures are so closely united that all appearance of a chain is lost, and one nearly uniform cord supplies its place, which, from the situation it holds in relation to the skeleton, namely, within the spinal column, is called the medulla spinalis, or spinal cord.

We have already observed in some of the Articulata how the gradual union of several ganglia constitutes a tolerably uniform cord, and how also the addition of ganglia to the single pair above the œsophagus which we saw in the sandhopper, so far increased the entire mass of neurine in that situation as to procure for it the title of cerebrum or brain; so also, even in the Vertebrata, whose organs of sense, the instruments by which the individual is brought into relation with the external world, are so much more perfectly developed, we do not find that the brain is separated from the spinal cord by any other line of demarkation than that of a greater disproportion in the size of the ganglia composing it. The further we advance, indeed, we meet with fresh proofs that the brain, even of the highest order of animals, is no more than a series of ganglia or collections of cineritious neurine, though without any peculiar uniformity of size in which the nerves from the different organs of sense terminate, and from which the nerves of volition originate. That these ganglia are larger and more numerous at the anterior than at the posterior extremity of the spinal cord, is simply in accordance with the evident marks of consummate design upon which every living being has been constructed; for all the organs of especial sensation, as sight, smell, hearing, and taste, are placed in that situation in the body where they have the greatest range for the exercise of their powers,—either in that portion which is in advance of the rest of the animal as he moves over the face of the globe, or, as in man, placed so completely above the rest of his frame, that they receive no impediment from it in the performance of their functions. These organs, from the high office they have to fulfil in the sphere of animal life, appear to require a large quantity of cineritious matter to accomplish their functions; in consequence of which the anterior extremity of the spinal cord is larger than the posterior. In this simple manner may we account for the relative proportion of the brain and spinal cord throughout the vertebrated class of animals up to man himself.

* Memoir, &c., p. 51.

In *Fishes* the common division of the nervous system into a brain and spinal cord, though arbitrary, it is nevertheless convenient to retain. The two portions in fact exhibit but a slight disproportion in general dimensions, although the mass of the spinal cord, as a whole, is very much more considerable than that of the brain or cerebral ganglia. Leuret states that the proportion of the weight of the brain of the fish to its body is as 1 to 566 lbs.*

The spinal cord in fishes bears a very great resemblance to that of man, differing from it only in the circumstance that the superior and inferior grooves which separate the cord into two lateral portions are much deeper. The superior groove, indeed, is so deep that it forms an imperfect canal, the internal surface of which is covered with a layer of gray matter. This canal exists in the human fœtus, and communicates by the calamus scriptorius with the fourth ventricle, which in reality is nothing more than a permanent dilatation of it. In the interior of the cord there is vesicular neurine, as in the higher animals, but there is so little difference of color that it easily escapes observation. Under the microscope it may be detected, and also some white fibres running through it at a right angle. These, I suppose, are the excito-motory roots of the spinal nerves.

The spinal nerves arise from the cord in fishes, by anterior and posterior filaments; an arrangement similar to that which is found in man, the posterior roots having, in like manner, a small ganglion connected with them. Mr. Holmes Coote, in his prize essay, states that these ganglia are only found in the cartilaginous fishes.

The form of the cord varies in the different kinds of fish very much in correspondence with the shape of their bodies. In the *Tetrodon Mola*, a short, thick fish, the spinal cord is not longer than the encephalon ; in the eel it is long and thin ; in the skate it is slightly enlarged opposite the large pectoral fins.

The cineritious neurine in which the nerves of sense, as the optic, auditory, &c., in the Butterfly and Sepia, terminate, and which in these animals, when fully developed, is collected into one rounded mass, the supra-œsophageal ganglion, in the fish is divided into several separate masses, so that almost every nerve terminates in a distinct and appropriate ganglion ; hence the peculiar appearance, as compared with that of man, which the brain of the fish presents.

There is in fact no set of organs in the human being which have less resemblance to the corresponding ones of the fish, in mere external appearance, than the masses of neurine contained within the cranium ; and I will venture to assert that there are few circumstances more startling to the anatomist who has confined his attention solely to the examination of the human brain, than the first appearance which the brain of a large fish presents to his view on removing the upper surface of the skull. Its minuteness as compared with the great size of the body, the number of its component parts, and their want of that concentration which is so peculiarly striking in the human brain,—a concentration, let it be remembered, deeply interesting, but which can only be duly appre-

* Anatomie comparée de système nerveux considerée dans ses rapports avec intelligence. par Fr. Leuret, tom i. p. 164 (1839).

ciated by him who traces with attention the structure of the nervous system through the chain of beings,—all give a mystery and confusion to the subject, which can only be solved by seriously considering and carefully drawing inferences from those facts which rest upon comparative as well as human anatomy for their support.

Among these facts there are none more important to us than these, viz.:—

That every nerve of sense, whether it be of the sense of smell, sight, hearing, taste, tact, or of simple sensation, has, at its central extremity, a collection of cineritious neurine, or ganglion. By the central extremity of a nerve we mean that which, in the ordinary language of anatomists, is called the *origin of the nerve*, but which in strict accordance with physiology ought to be called its termination; for the term origin is not merely incorrect as regards the function of the nerves of sensation, but also as regards their development; all the nerves being formed in the extremities and trunk previous to their connection with the brain and spinal cord, in conformity with the law of concentric development, or development from the circumference to the centre. In the human embryo, for example, we find that when the nerves first engraft themselves upon the spinal cord, the external layer of medullary matter is extremely thin, and the nerves appear to be simply in contact with the cord, but that in proportion as new fibrous layers are deposited, the nerve is enveloped by them, and becomes, as it were, dovetailed into the fissures of the fibres.

But the brain of fishes does not consist simply of ganglia, in which the nerves of sensation terminate; there are other parts which must, I think, be viewed as a decided advancement, in accordance with their manifestation of higher instinct and an approach to the intellectual faculties of memory and judgment. These parts are therefore, in all probability, the instruments by which some further process is effected, approaching in its nature to the mental operations of man, such as judgment, of course extremely limited in its nature, remembrance of sensations, &c. If this view be correct, these parts must be analogous to the hemispheres of the human brain, for most physiologists of the present day agree with the opinion given by M. Cuvier, in his report to the Academy of Sciences at Paris, on M. Flourens' work, namely, that the cerebral lobes or hemispheres are the organic parts in which the impressions made on the organs of sight and hearing become perceptible to the animal, and that probably there too all the sensations assume a distinct form, and leave durable impressions; that the hemispheres, in short, are the abode of memory, and from this circumstance, therefore, a source to the animal of the materials for judgment.

Besides these parts, which in all probability are analogous to the hemispheres of the human brain, there is a structure which corresponds to the cerebellum. Its office has not yet been clearly ascertained, though, for reasons to be mentioned hereafter, there can be little doubt that it is in some way or other connected with the production of that combined action of the muscles which is essential to progressive motion, and which would seem to require appropriate nervous parts for its direction and control.

If we do not take this view of the composition of the brain of the fish, we must remain satisfied with the obscurity in which all writers on comparative anatomy have left this subject, and be content to see the chain of progressive development from the lowest animals up to man, broken, by which the study of the nervous system in these animals, instead of assisting us in unravelling the structure of the human brain, would only plunge us into fresh difficulties.*

Serres† was well aware of the backward state of information in regard to the anatomy of the brain of fishes. He thus expresses himself:—

"Considered as a whole, the encephalon of the fish is the most simple in nature; it is the most complicated in our writings; it is an inextricable labyrinth in our books. Why this contradiction between nature and our writings? There exist many reasons for it; the principal one, that from which all the others flow, is the infinite variety which the brain of the fish presents to our notice. Nature seems to have employed all her riches on these animals. Their brain varies not only from family to family, but essentially differs from genus to genus; and even from species to species there is continued metamorphosis going on. These variations do not consist solely in changes of form of position, or of relation in the same elements: some entire parts are transformed, left out, and again reproduced."

Notwithstanding these prefatory observations of Serres, I confess that he does not appear to me to have considered the structure of the brain from that simple point of view from which I consider it may very readily and very advantageously be regarded.

One reason for this is, that in most of his descriptions and illustrations, he omits altogether the olfactory tubercles, unless they are very large, as in the skates and sharks, or close to the hemispherical ganglia, as in the eel; consequently, repeatedly confounds the two.

Leuret enumerates eight cerebral ganglia: 1. Olfactory; 2. Cerebral; 3. Optic; 4. Quadrigeminal; 5. Cerebellum; 6. Ganglia of the trifacial; 7. Ganglia of the seventh and eighth; 8. Those which exist at the base of the brain between the decussation of the optic nerves. Leuret has fallen into the same error as Serres: for instance, he states that in the brain of the codfish, the olfactory ganglion and the cerebral are united so as to form only one, and in Plate II. he gives the brain of the codfish, omitting the olfactory ganglion altogether, and calling the hemispherical ganglion, "Tubercle ethmoidal, or cerebral;" and in the figure of the brain of the eel, where the olfactory tubercle is so close that it cannot be omitted, he then designates it, "Tubercle ethmoidal;" and the hemispherical ganglion, "Tubercle cerebral." The difference in the position of the olfactory ganglion is interesting, but it does not deprive it of its title to be considered as a portion of the cerebral mass.

In order to prove the correctness of this view, let us direct our attention to a few specimens of the brain of fishes, commencing with the more simple forms, and proceeding gradually to the more compli-

* It is gratifying to the author to find that this view of the homology and physiology of the cerebral ganglia of the fish, which was first enunciated in the first edition of this work in 1836, is now almost universally adopted.

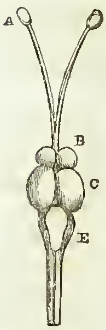
† Anatomie Comparée du Cerveau, tom. i. p. 184.

cated. For this purpose I have, intentionally, selected the brains of those species which are most easily obtained.

But, before proceeding to the description of the brain of any particular fish, let me remark, that there is a striking peculiarity in the brain-case or cranium of fishes as regards its relation to the dimensions of the cerebral mass. In most species of fishes, the cavity of the skull is nearly double, and, in many instances, nearly treble, the size of the included brain. In the head of the skate and cod, this difference is particularly obvious: the space, which is left between the surface of tbe brain and the walls of the cranium, is filled up with a loose cellular membrane containing a quantity of gelatinous fluid, and evidently answers the same purpose as the arachnoid in those instances where the brain is closely surrounded by the bones of the skull. In the sturgeon, again, there is no such vacancy —a circumstance which it is important to bear in mind, in order to avoid injuring the brain when opening the skull of this cartilaginous fish.

The brain of the whiting, haddock, and the cod, are exactly alike. The whiting has been selected, because its skull is soft and easily opened. The skull of the codfish, which are brought to London, is almost always fractured and the brain injured. The fisbermen always stun them by a blow on the head. The student, before he removes the brain, had better study fig. 26: else, he will commit the same error which Serres and Leuret have done, and some physiological writers, who have copied their plates without dissecting the fish, and describe the termination of the olfactory commissures in the hemispheres as the olfactory ganglia; as they either leave them in the skull, when they remove the brain, or, if they examine the brain *in situ*, they neglect to uncover the ganglia.

Fig. 26.



Brain of the whiting the size of life, seen on its upper surface. A. Olfactory ganglion. B. Hemispherical ganglion. C. Optic ganglion. E. Cerebellum.

The whiting.—If, in this fish, we view the cerebral mass from above, proceeding from before backwards, we observe three rounded masses or nodules of neurine, and a triangular shaped medullary leaflet, which overlaps that fissure of the cord called the fourth ventricle.

The first pair are the olfactory ganglia, lying on the cribriform plate of the ethmoid bone, where they are joined by the olfactory nerves, as they are in man. They are about the size of large pins' heads, and their being situated at some distance from the rest of the cerebral mass, is, I suppose, the reason they have escaped the observation of most anatomists, and are not included by Serres in his description of the component parts of the brain in this fish. To me they nevertheless appear to be as decidedly a portion of the cerebral mass as the optic tubercles or ganglia, in which the optic nerves terminate, and which are always included in the description of the fish's brain. The commissure or apparatus of union which connects this ganglion with the rest of the encephalon is thin and thread-like, resembling a nerve in its appearance, and about an inch in length. Some authors have stated that the olfactory tubercles in the osseous fishes are generally in contact with the cerebral mass; but the brain of the whiting, as well as of many others, forms an exception to the rule. The next masses, about the size of a

small pea, are analogous to the human hemispheres, and may be designated the hemispherical ganglia: they are connected together by a transverse commissure, the anterior commissure. It is particularly interesting to observe how closely these hemispherical ganglia of the whiting correspond with the cerebral hemispheres of the human embryo at the seventh week. These bodies, however, are described by Tiedemann* as analogous to the corpora striata rather than to the hemispheres of the brain, and by Desmoulins to the optic thalami. With all deference to the talented authors of these opinions, I must say that I do not imagine either of these analogies to be founded in fact. The corpora striata and optic thalami in man and the Mammalia, are structures formed so entirely of fibres intermingled with cineritious neurine, either terminating in, or arising from, the hemispheres, that I cannot conceive how they should exist if the hemispheres themselves, from which they derive their origin, and in which they terminate, were altogether absent.

Nevertheless it is not true, as some authors have stated, that these ganglia always hold an exact relative size to the hemispherical ganglia.

The next pair of nodules are the optic ganglia or tubercles, analogous to the tubercula quadrigemina in man.†

Leuret does not employ the term optic lobes as synonymous with tubercula quadrigemina, which most anatomists of the present day agree in considering the true optic tubercles.

* Tiedemann on the Fœtal Brain; translated by Bennet, p. 230.

† By the translator of Carus's Comparative Anatomy (Mr. R. T. Gore) it is said, in page 240, that the identity of these middle cerebral masses with the corpora quadrigemina is fully proved by a reference to the progress of formation of the same parts in the fœtus of man and other Mammalia. In the early periods of the existence of the human fœtus, the corpora quadrigemina contain a capacious ventricle, subsequently filled up by the deposition of nervous matter, so as to leave only the narrow passage known as the aqueduct of Sylvius. This ventricle is covered over by two thin medullary laminæ, in contact with each other, though not united, along the mesial line, and contains elevations or ganglia similar to those here described. (Tiedemann, *l. c.*, 186.) According to him, however, they represent not merely the anterior, but rather both pairs of the corpora quadrigemina. Their size is directly proportioned to that of the eyes and optic nerves, being small in the conger eel and burbot, of moderate size in rays and sharks, and considerably larger than the first cerebral mass in the trout, pike, garpike, salmon. carp, uranoscopus, sparus, scorpœne, perch, &c. In the genera Sparus, Scorpæna, Clupea, Mugil, Scomber, Zeus, Trigla, &c., the optic nerve, arising on each side from the middle cerebral mass or optic tubercles, consists of a membranous expansion, disposed in longitudinal folds like the leaves of a closed fan, though inclosed within a cylindrical neurilemma, which, however, adheres so loosely as to allow the folds to glide one upon another. In the *Trachinus Draco*, where the diameter of the nerve is about a line, there are nine or ten folds, which, when expanded, form a membrane nerve is almost in a rudimentary state, its length and the thickness of the neurilemma being eighteen or twenty lines wide. In the pleuronectes, murænæ, rays, sturgeons, &c., the optic proportionally very considerable. In a sturgeon four feet long, the diameter of the nerve was not above three-fourths of a line, and the medullary matter contained within it less than one-fourth of the whole, the rest being formed by neurilemma. In the Ammocetus the nerve is wanting, though there is a rudiment of the eye. (Desmoulins, *l. c.*, p. 325, &c.) In the *Cyclopterus Lumpus*, the nerve on each side consists of from twenty-five or thirty parallel filaments, each covered by a separate neurilemma, and collectively inclosed within a common cylindrical sheath so loosely as to allow of motion one upon the other. The most remarkable circumstance, however, is that the cerebral termination of each nerve is continuous with that of the other; the extremity of the neurilemma of each filament and the ends of the common sheath of each inosculating, as it were, together. The point of union of the common sheaths of the filaments of each side is connected with the brain merely by very fine cellular tissue, without the interposition of any medullary matter, and so loosely as to admit of being separated by the least effort. (Desmoulins, *l. c.*, 330, Plate IX. fig. 3.) The nerves in this case do not decussate.

These are his words :* "*Optic Ganglia.*—Haller, Vic d'Azyr and Carus, have called them thalami optici; Camper, cerebral hemispheres; Scarpa, great tubercles of the brain ; Treviranus, posterior hemispheres; Cuvier, hollow lobes; M. Serres, M. Desmoulins, M. Gottsche, optic lobes. In some fish, in which the optic ganglia are the largest, there is always that white appearance which belongs to a medullary substance. In osseous fishes they are always uncovered ; in the skate and the shark there is a portion concealed by a prolongation of the cerebellum. At first sight, and especially if examined after being in spirit, their appearance is throughout the same, but in a fresh state we can trace, upon the internal and superior surface, one of the roots of the optic nerve ; and upon the external inferior surface a second root of the same nerve. They are in exact proportion to the size of the eyes: Gottsche has observed in those which have the eyes of unequal size, in the Pleuronectes, for example, sole, turbot, &c., that the optic lobes are unequally developed. If we divide these lobes, we see that they do not constitute really a ganglion, but that they are formed by a very fine fibrous lamina. The optic laminæ on one side is adherent on the internal surface to the corresponding laminæ on the opposite side, and at the point of this adherence it consists of fibres which run from right to left: these fibres form there a true commissure, and represent the corpus callosum, as we shall see presently. The optic laminæ form the walls of a double ventricle, separated, the right from the left, by a small lamina analogous to the interventricular lamina or septum lucidum of superior animals. The interior of these ventricles presents different appearances, according to whether it belongs to an osseous or cartilaginous fish. In the former, we perceive first a white commissure which unites the anterior portion of the two optic lobes; behind this commissure, the anterior prolongations of the spinal cord, which is found below all the cerebral ganglia, to which they serve as the base, leaving between them the infundibulum or lower part of the third ventricle of the mammiferæ ; behind the infundibulum, another or posterior commissure, analogous to the preceding; at length, above this commissure, a tubercle, flattened, bilobed, furnished with two long appendages of a medullary substance of a whitish gray. The bilobed tubercle represents the tubercula quadrigemina, and below is the aqueduct of Sylvius, which forms a communication between the cavity of the optic ventricles and another ventricle placed under the cerebellum. On each side, the ventricle of the optic lobe presents a small tubercle (tori semicirculares of Haller, the semicircular collar of Cuvier, the anterior internal ganglions of Carus), which is analogous to the corpus striatum."

"In cartilaginous fish, the cavity formed by the optic lamina does not present any commissure, nor the tubercular quadrigemina very distinctly, but only the infundibulum and the commencement of the aqueduct of Sylvius."†

M. Serres thus describes the optic tubercles in fish, considering them analogous to the tubercula quadrigemina in man. His words are,—"Thus we see the tubercula quadrigemina exist in osseous fish: they are in direct communication by their posterior extremity with the cere-

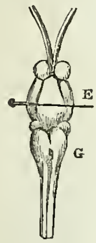
* Op. cit., p. 140.

* P. 142, op. cit.

bellum, and there is a true *processus è cerebello ad testes:* by their anterior part they are continued into a long lamina, which curves upon itself, and covers a large portion. When we examine the brain of the carp, we see behind and within these optic ganglia two oblong bodies, which are nothing but the folded extremity of these laminæ."

The next division of the whiting's brain is the triangular leaflet, the analogue of the cerebellum or little brain in man. These parts comprise the whole of the nervous masses which can be observed by merely looking upon the upper surface of the cerebral mass of the whiting; but if we raise the optic tubercles, we find that instead of their being solid, as they appear, they are hollowed out internally: and by turning them back, we observe two small rounded projections, which appear to be merely continuous portions of the same ganglia, bearing some resemblance to the posterior of the quadrigeminal bodies called the testes in the human subject. By raising the cerebellum we also observe that the spinal cord lying beneath it is much thicker than the same part lower down; in fact, that fresh neurine has been added to it on each side, in the shape of two oval bodies, the nature of which, or the analogy they bear to particular portions of the human brain, it is not easy to discover in the whiting; but, as will be seen afterwards by reference to other fishes, it is highly probable that they correspond to the posterior pyramidal bodies or auditory ganglia, together with the ganglia of the pneumogastric nerves in man, the branchiogastric nerve in the fish taking its rise from, or being in direct communication with, them.

Fig. 27.



Brain of the whiting; the cerebellum being turned up, and the branchiogastric ganglia displayed.
E. Cerebellum.
G. Pneumogastric ganglion.

If the whole encephalic mass of the whiting, having been removed from the skull, be reversed, and the under surface exposed, two oval-shaped cineritious bodies may be observed. "These bodies," says Spurzheim,* "probably correspond to the gray tubercle (tuber cinereum) of Mammalia. This tubercle, in the higher classes of animals, always sends fibres to the optic nerves, which, after this accession, advance in their course of increased size." Carus entertained the same opinion, while Cuvier regarded them as the true optic tubercles. The use of the tuber cinereum in man certainly has not yet been ascertained; but it is much more probable that these oval-shaped cineritious bodies of the fish are analogous to them, than to the corpora mammillaria, as conjectured by Serres; for the corpora mammillaria being portions of the fornix in man, cannot be supposed to exist where that structure is wanting, as it is in the fish.

The brain of the cod so closely resembles that of the whiting that it will not require any particular description; but I have introduced a drawing (after Serres), to show the optic ganglia turned back (fig. 28), exhibiting the connection of the olfactory nerves with the hemispherical ganglia, and with the continuous fibres of the spinal cord.

The Carp (fig. 29).—On first exposing the brain of the carp, we are struck with the great dissimilarity which it presents to that of the species

* Anatomy of the Brain, 1826, p. 38.

of fish last described. Instead of only four divisions, we here distinctly observe no fewer than seven. A little consideration, however, will con-

Fig. 28.

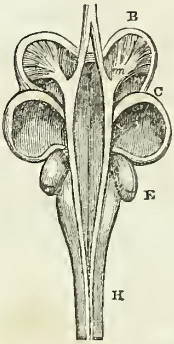


Fig. 29.

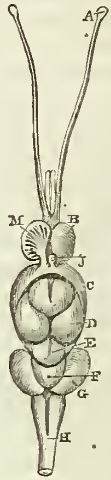


Fig. 28.—(From Serres' *Anatomie Comparée du Cerveau.*) The brain of the codfish, unfolded to expose the continuation of the spinal cord and its connection with olfactory nerves. B. Hemispherical ganglion. C. Optic ganglion. E. Cerebellum. H. Spinal cord. *m.* Corpus striatum.

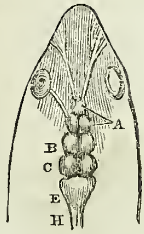
Fig. 29.—Brain of the carp, removed from the skull, and seen from above. A. Olfactory ganglion. B. Hemispherical ganglion. C. Optic ganglion. D. Testes, or posterior optic ganglion. E. Cerebellum. F. Auditory ganglion. G. Pneumogastric ganglion. H. Spinal cord. J. Pituitary gland. M. Corpus striatum.

vince us that there is no essential difference between the brain of the whiting and that of the carp, but that the analogy is perfect and the chain of structural uniformity yet unbroken. The first pair of nodules, which are small, are the olfactory ganglia, and, like those of the whiting, situated on the ethmoid bone, at some distance from the remainder of the encephalon. The commissure connecting them in a carp seven inches in length was a little more than an inch long. The second pair are the cerebral hemispheres, but extremely small as compared with the same parts in the cartilaginous fishes. The third and fourth divisions evidently belong to the optic ganglia, and not to the hemispherical, for we find the pineal gland situated between the two. The optic ganglia are hollow in all fish, as we have seen in the cod, but in the carp the covering is imperfect, as we see in fig. 29, representing the brain as seen from above: letter C runs to this lamina, and D to the internal portion. At the base of the brain may be observed a large pituitary gland and infundibulum. The cerebellum is the next mass, and immediately behind it are the auditory ganglia, analogous to the posterior pyramidal bodies in man. On each side of these ganglia are placed those bodies from which the branchiogastric nerves arise, analogous to the pneumogastric ganglia, which are placed to the inner side of the restiform bodies in the human subject. These bodies are stated by Cruveilhier* to be of enormous size in the Electric Ray, in whom the branchiogastric nerve is so amazingly

* Op. cit.

developed. The hemispheres, though solid, consist of two portions, the exterior or cortical substance, the hemispherical ganglia, and a bed of vesicular neurine in the centre, through which white fibres of the cord may be seen spreading towards the circumference, separated from each other by gray neurine.—(See fig. 30.) It is identical with the corpus striatum of the human brain.

Fig. 30.

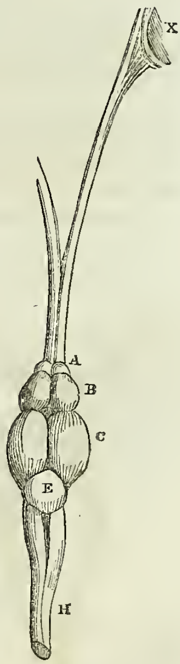


The brain of the eel, seen from above. A. Olfactory ganglion. B. Hemispherical ganglion. C. Optic ganglion. E. Cerebellum. H. Spinal cord.

In the common eel we have an appearance of variety, which simply arises from the circumstance of the *olfactory tubercles* (which in the whiting, carp, &c., are situated on the cribriform plate of the ethmoid bone, at the distance of nearly an inch from the rest of the cerebral mass) being placed close to the hemispheres; this, and also their being slightly grooved transversely on their upper surface, gives to the whole cerebral mass the appearance of a long chain of tubercles, which have no resemblance to the component parts of the brain in the last-mentioned fish, so that there appears at first sight to be no analogy; the number of essential parts is, however, in reality the same, and the analogy between them perfect; the only real difference consists in their relative size and the distance at which they are situated from one another.—(Fig. 30.)

In the pike, also, the olfactory ganglia are placed close to the hemispherical, and if the olfactory nerves are traced to the nose, they will be seen dividing into several branches, but without forming any bulbous enlargement, passing through a membrane which corresponds to the cribriform plate of the ethmoid.—(See fig. 31.)

Fig. 31.



Brain of the pike. A. Olfactory ganglion. B. Hemispherical ganglion. C. Optic ganglion. E. Cerebellum. H. Spinal cord. X. The olfactory nerve penetrating the cribriform plate of ethmoid bone, without any *bulbous* enlargement.

In the cartilaginous fishes the form of the brain approaches so much more nearly to that of the higher orders of animals, that at first sight the cerebral mass in one of the Rays, as the common skate (figs. 32 and 33), appears to differ essentially in its component parts from that of one of the bony fishes which we have hitherto been describing particularly. There is, however, no essential distinction; the difference arising solely from the greater concentration of similar or nearly similar parts.

The olfactory ganglia in the skate are extremely large, as will be seen by referring to the diagram (fig. 32). The peduncles are long, and the cerebral hemispheres form a more considerable mass, slightly irregular upon its surface, and thus assuming an approach to a convoluted arrangement of the superficies. These hemispheres are solid, as we have seen in the carp; the white fibres may be seen entering at the posterior extremity, and separated by gray neurine in like man-

Fig. 32.

The brain of the skate, removed from the skull, and seen from above. A. Olfactory ganglion. B. Hemispherical ganglion. C. Optic ganglion. E. Cerebellum. G. Pneumogastric ganglion.

ner. The optic tubercles have also increased in size, and are connected with the hemispheres by distinct medullary bands.

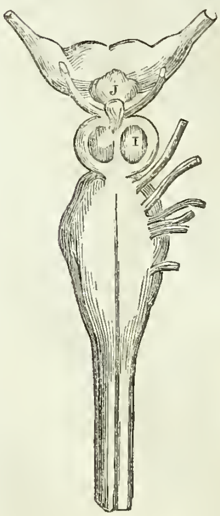
But the cerebellum is found to have undergone the greatest alteration of any part; for it is no longer a mere triangular leaflet, but is divided into lobes, and partly overlaps the optic tubercles. But the hemispherical ganglia are not yet separated from the corpora striata by any interspace or ventricle. This covering is first found in the sharks. The transverse commissure is very distinct (see fig. 32).

In the sharks, the cerebellum is much larger and more complicated than in any other fish. It very much resembles that of the bird, consisting of transverse laminæ.

The advance in the size and complexity of the cerebellum is interesting when we remember the great locomotive powers of these fish; and the fact that they are entirely dependent on these powers, not merely for locomotion, but for their buoyancy, for they do not possess any air-bag, like the osseous fishes.

On each side of the cerebellum in the skate there is an extensive layer of folded neurine, from which a considerable portion of the branchiogastric nerve arises. It is the analogue of the respiratory ganglia in the Mollusca, &c., and the pneumogastric or restiform ganglia in man; we shall also find a portion of the nerve corresponding to the fifth nerve of Mammalia connected with it (G). Leuret describes it as partly the branchiogastric ganglion and partly a ganglion of the fifth pair. Serres considers this structure as forming a portion of the cerebellum. Spurzheim does not agree with him, though he does not form the same conclusion which I have done.

Fig. 33.



Brain of the skate seen on its under surface. I. Tuber cinereum. J. Pituitary gland.

On reversing the position of the brain (fig. 33), we observe the two small tubercles (I) of medullary neurine, believed to be analogous to the tuber cinereum in man, a part whose character, as before stated, has not yet been ascertained. I am glad to find that Leuret agrees with the view of the homology of these ganglia, which I enunciated in my first edition. The pituitary gland (J) is large in this fish, and seen distinctly in fig. 33.

From the Fish, let us direct our attention to

some specimens of the cerebro-spinal axis in *Amphibia*. The most familiar example of this class is our common frog.

Fig 34.

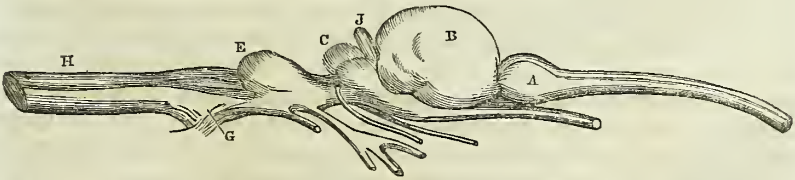
Side view of the brain of the frog. A. Olfactory ganglion. B. Hemispherical ganglion. C & D. Optic ganglion.—When C and D occur in the same figure, C signifies *anterior* optic ganglion. E. Cerebellum. H. Spinal cord. R. Pineal gland.

In this animal the olfactory ganglia are brought close up to the hemispheres, as in the eel (see fig. 30) instead of being at some distance, and connected by long peduncles, as in most other fish. The hemispheres (B), larger in proportion than in fish, are nearly double the size of the optic ganglia. They are hollow, and contain within, a distinct corpus striatum, or anterior cerebral ganglion, which will be better seen and better understood in the classes above the Amphibia. The optic ganglia (C and D) are distinct, and covered with a dark membrane. The pineal gland is small but distinct. The cerebellum is peculiarly small, forming only a narrow tongue across the posterior surface of the cord. This simple form of cerebellum, according to Leuret, exists also in the toad, lizard, terrestrial salamander, snake, and newt.

The pneumogastric and auditory ganglia do not project on the surface, but ganglionic neurine may be seen in their usual situation, when a transverse section is made of the medulla oblongata.

Reptilia.—From this class we may select the turtle: specimens are easily procured, and its brain is extremely simple (fig. 35). The olfactory ganglia, instead of being situated on the cribriform plate of the ethmoid bone, are placed, as in the eel, almost close to the hemispheres, and the commissures connecting them are therefore extremely short: they communicate internally with the ventricles. The olfactory nerves pass towards the cribriform plate of the ethmoid, but there is no bulbous enlargement at that spot. They split into small filaments, which pass through separate foramina. The cerebral lobes or hemispheres are larger and more perfectly developed than in the Amphibia or in any of the finny tribes.

Fig. 35.

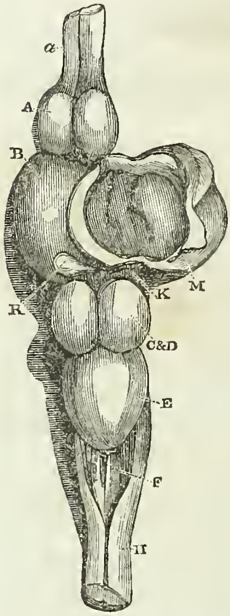


Side view of the brain of the turtle. A. Olfactory ganglion. B. Hemispherical ganglion. C. Optic ganglion. E. Cerebellum. G. Pneumogastric ganglion. H. Spinal cord. J. Pituitary gland.

These ganglia are hollowed, and when opened (see fig. 36) the corpus striatum or anterior cerebral ganglion (M) may be seen: it is of large size. A section of this ganglion exhibits a striated appearance very

similiar to that in the human being; posterior and external to the ventricle is another enlargement (K), which I suppose is the analogue of the thalamus or posterior cerebral ganglion.

Fig. 36.



Brain of the turtle seen from above, lateral ventricle opened. *a*. Olfactory nerve. A. Olfactory ganglion. B. Hemispherical ganglion. C & D. Optic ganglion. E. Cerebellum. F. Auditory ganglion. H. Spinal cord. K. Thalamus nervi optici. M. Corpus striatum. R. Pineal gland.

Leuret designates this enlargement in the ventricle of the turtle the corpus striatum, but he says nothing of the smaller projection just exterior to it, and anterior to the optic ganglia.

The optic tubercles are placed immediately behind the optic thalamus. The hemispheres are joined to the cerebellum by two medullary processes, the analogues of which, in the human brain, are called the processus è cerebello ad testes; and as these parts form a commissure between the anterior portion of the cerebral mass and cerebellum, I have, in my description of it in the human brain, called it the intercerebral commissure. It is from this part that the fourth pair of nerves arise both in man, and the Vertebrata generally. Between the opticle tubercles and the hemisphere is the pineal gland, of an elongated form, soft, consisting only of blood-vessels.

The cerebellum (E) of the turtle, though distinctly formed, is small, and consisting of a single lamina. It is smooth and convex above, and hollowed below, and, with a slightly pointed extremity, covers in the posterior fissure of the cord. The auditory ganglia and respiratory ganglia are scarcely perceptible. The first circumstance is accounted for by the sense of hearing in these animals not being acute ; in fact, all their sensations are peculiarly dull, and, in the second place, the "besoin de respirer," as the French express it, is not the violent, uncontrollable sensation which is evidently experienced by fishes, and the higher order of animals, when the access of air is by any accident impeded. Now, I have shown elsewhere that this peculiar sensibility is entirely annihilated, if the pneumogastric nerve be divided ; and it is, therefore, very evident that on this nerve, as a nerve of sensation, the high degree of sensibility peculiar to the respiratory organs in the higher animals depends. The deficiency in these animals of that perfectly developed system of respiratory muscles found in most of the Vertebrata, viewed in connection with the diminutive size of these respiratory ganglia, supports the opinion advanced elsewhere, that from these bodies issue the orders for the respiratory muscles to act.

It is worthy of remark, in confirmation of the views regarding the office of the cineritious neurine, which I have laid before the reader elsewhere, that the spinal cord of the turtle is immensely enlarged opposite to the anterior and posterior extremities, the muscles of which are supplied by it, whilst between these points it is contracted to a mere

thread; the intercostal system of muscles being entirely deficient, and instead of an extensive surface of skin requiring a supply of nerves of sensation, as in man and the Mammalia generally, there is a hard, insensible carapace.

In all the Reptilia the hemispheres are much alike in their smallness and simplicity. They vary a little in shape.—In the crocodiles they are wide posteriorly and narrow in front—something of a heart shape. In serpents they are wider from side to side. In all the saurians, crocodiles, lizards, &c., and in the serpents, the cerebellum is very small and very simple.

Birds.—The brain and spinal cord in birds are developed after one uniform type, notwithstanding the amazing diversity of external form, habits and instincts of the different species of these creatures.

The evident advancement in intellectual powers, which this interesting tribe of the animal kingdom exhibits to us, is found to correspond with a greater development of the hemispheres of the brain. The proportion of these to the size of the body, to the other cerebral ganglia, and, lastly, to the spinal cord, is far superior to anything we have met with in the preceding classes. The different ganglia, composing the encephalic mass, are not placed one after another, as in the skull of fishes and reptiles, but, on the contrary, are rather placed under one another, and the hemispheres or cerebral lobes are so much increased in size that they cover all the different ganglia of the nerves of sensation; so that on viewing the cerebral mass of birds from above, we observe only two divisions—the hemispheres or cerebrum, and the cerebellum; in some instances the cerebrum is so large as even partly to overlap the cerebellum (fig. 37).

Fig. 37.

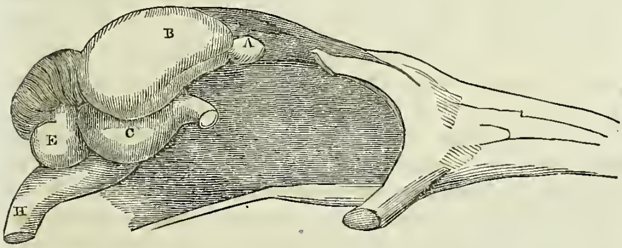


Fig. 38.

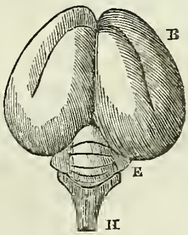


Fig. 37.—Side view of the brain of the bird, showing its position in the skull. A. Olfactory ganglion. B. Hemispherical ganglion. C. Optic ganglion. E. Cerebellum. H. Spinal cord.

Fig. 38.—Upper surface of the brain of the woodpecker (Leuret), showing the first commencement of the convolutions. B. Hemispherical ganglion. E. Cerebellum. H. Spinal cord.

The cerebral lobes in most birds still present a smooth surface, but in some birds there is a slight furrow, which is the first trace we meet with of that folded or convoluted appearance which is so characteristic of the brain of the highest order of animals. The brain of the common fowl, pigeon, magpie, blackbird, loriat and crow, is perfectly smooth (see fig. 37); but that of the buzzard and cuckoo is slightly furrowed. In the duck and woodpecker this is distinct (fig. 38); and "in the parroquet it is more distinct (says Leuret) than in any bird I have examined."*

* Leuret, p. 277.

The cerebral hemispheres are not hollow, as in fish and reptiles. And let it be remembered, that this convoluted arrangement is adopted simply for the purpose of obtaining a larger surface of cineritious neurine in a smaller space. The amount of surface presented by a convoluted brain, if extended evenly, would cover a very large space, and take up a great deal of room; it would consequently require a skull of corresponding dimensions to contain it, with proportionally large muscles to move the head. Folded backwards and forwards, however, in the beautiful manner in which we find the brain arranged in man and the Mammalia generally, it takes up but little room, and is packed into a comparatively small box, which does not then interfere with the active powers of locomotion, so important to all the higher animals in maintaining their relations with the external world.

The cerebellum in birds is peculiarly large—a fact which tends to confirm the views of many intelligent physiologists of the present day, that it presides over and combines the action of separate muscles so as to produce an harmonious result; for the perfection which the organs of locomotion attain in this class very far surpasses all that we have yet observed among fishes and reptiles, and equals at least the degree of development exhibited by the same organs in any other species or class of living beings; the cerebellum is divided by transverse furrows into laminæ varying in number from 10 to 20. Leuret names 12 in the partridge, 15 in the duck, 16 in the parroquet, 20 in the male magpie.

Nevertheless the cerebellum of the Bird differs from the same organ in the Mammalia in one important particular; the lateral lobes of the cerebellum are almost wholly deficient in birds; in man they are so much developed that the central portion, consisting of the superior and inferior vermiform processes, has even been described by Reil as constituting a mere commissure. The cerebellum of the Bird consists, in many species, of little more than the middle lobe, which, corresponding to the vermiform processes of the Mammalia, proves that these processes, instead of constituting a commissure, form the fundamental, and consequently, we may suppose, the most essential portion of a cerebellum. Serres* remarks, that this analogy, which was first observed by Haller, was rejected by Malacarne, and neglected by most subsequent anatomists. The lateral hemispheres, observes the same author, in some birds are so small as scarcely to be visible; for instance, in the common fowl, the duck, the goose, the wren, canary-bird, and sparrow: but they are very distinct in partridges, pigeons, swallows, birds of prey, the ostrich, the cassowary and the storks. In general, in birds which elevate and sustain themselves a long time in the air, as the stork, and those whose wings or feet have great power, as the emu, cassowary, and parrots, these hemispheres appear most developed.

The olfactory ganglia are small in birds, and, as in some fishes, are placed close to the cerebral hemispheres, so that the commissures, or peduncles as they are sometimes called, are peculiarly short, presenting little more than a white line, which runs to the outer side of the hemispheres.

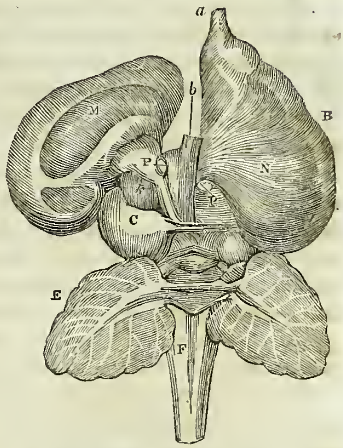
* Anatomie Comparée du Cerveau, vol. ii. p. 372.

The optic tubercles, on the contrary, are very large, as are also the nerves which arise from them.

The medulla oblongata is more than double the size of the spinal cord, both in width and depth; the corpora pyramidalia, the olivary bodies and pons Varolii are absent.

The hemispheres of the brain are connected together by a small transverse commissure, consisting of cineritious matter on the exterior, of filaments of medullary matter, of the size of a thread, in the interior; the analogue of the anterior transverse commissure in man, (see fig. 39, P,) which represents the two divided ends of it. It has been cut in separating the hemispheres. On the internal surface of the hemispheres (those two surfaces which are opposed to each other, and in the human brain are separated by the falx major), we observe some diverging fibres of medullary neurine, which present themselves as a sort of footstalk at the under part of the hemispheres, but really commence by two portions, the one from the outer edge of the tractus opticus, the other from the inner. That which takes its course to the outer side is connected with the tractus opticus, while the internal appears to terminate in the tuber cinereum. This structure appears to me analogous to the fornix in man.—(See letter N, fig. 39.)

Fig. 39.



The brain of the goose laid open. (From Spurzheim.) On the right hand side may be seen the internal surface of the hemisphere without any section. The white fibres on the surface belong to the fornix or longitudinal commissure. On the left side, a section of the hemisphere has been made, below that called the *antrum ovale* in the human brain; it lays open the lateral ventricle, exposing the corpus striatum (M) and the thalamus (*k*). The small transverse commissure, analogous to the anterior commissure in man, is divided. (P). There is no corpus callosum. *a*. Olfactory nerve. *b*. Optic nerve. B. Hemispherical ganglion. C. Optic ganglion. E. Cerebellum. F. Auditory ganglion. N. Longitudinal commissure, or fornix. P P. Great transverse commissure.

In the brain of the Bird we again distinctly observe those collections of cineritious neurine through which the fibres of the anterior and posterior columns of the spinal cord proceed in their passage towards their termination in the hemisphere. These nodules or tubercles, which in the human subject are called the corpora striata and thalami nervorum opticorum (fig. 39), may be seen in the Bird by separating the hemispheres and breaking down the commissure which connects them. They will then be observed partly covered by the optic tubercles. In birds the corpora striata are very large, the thalami small. As they are more perfectly developed in all the genera of the succeeding class, I shall not at present dwell longer upon the character they exhibit.

Brain and Spinal Cord in the Mammalia.—The division of this class into two sub-classes, the Placentalia and Implacentalia, by Professor Owen, and the philosophical researches of this admirable anatomist, into the organization of the Implacentalia, necessitate our considering them separately. It is found that the brain of the lowest mammal is but little in advance of the Bird; and that assertion of Cuvier, that the pons

Varolii and corpus callosum are peculiar to the Mammalia, is not applicable to the Mammalia as a whole, but only to the Placentalia. (The Implacentalia are divided into Monotremata and Marsupiata.)

The Monotremata derive their name from their having a common opening for fæcal evacuation and the generative function, like the birds; the ornithorhynchus, or duck-billed platypus, is our most familiar example.. The brain of this animal is extremely simple; the hemispheres are small and smooth like the bird, the whole brain only bearing a proportion to the body of 1 to 130.

The optic tubercles are covered more completely than in the Bird, and they are partially divided, shadowing forth the complete division into four bodies, which we meet with in the placental Mammalia. "The posterior bigeminal body," says Owen, (Art. Monotremata, Cyc. Anat., vol. iii. p. 383,) "is much smaller than the anterior, and the transverse depression which divides them is very feebly marked; the longitudinal groove is equally feeble on the nates, and is altogether absent in the testes, which thus form a single tubercle."

The commissural apparatus presents the same peculiarity and deficiency as in the Marsupiata to be described presently. Thus we do not find any sudden transition from one form of brain to another; there is no great chasm between the brain in birds and that of the Mammalia.

Mr. Owen, in his interesting paper on the brain of Marsupiate Animals, published in the Philosophical Transactions, Part I., 1837, has shown that the link between birds and Mammalia is more perfect than was previously believed.

The commissural apparatus in birds we have already seen is extremely simple, consisting of a mere cord-like transverse commissure and a rudimentary fornix.—In the rodent, or gnawing Mammalia, as the rat, mouse, squirrel, rabbit, beaver, the hemispheres are almost as smooth as in birds, but the commissural apparatus is nearly as perfect as in man, as the student will perceive when he reads the description of the brain of the rabbit, given a little further on.

In the marsupiate animals, however, it is very different, for the great transverse commissure, or corpus callosum, is scarcely larger than the anterior commissure in the Bird, and the fornix is quite rudimentary.*

The brain bears a smaller proportion to the body in the marsupials than in any other order of mammals: thus in the Ursine Dasyure it is as 1 to 820, in the Wombat as 1 to 614, in the Kangaroo as 1 to 800. Mr. Owen thus states how he was led to the discovery of this important distinction between the structure of the brain in the placental and marsupial Mammalia.

"From the fact that the cerebral organ is that which exhibits the most marked degradation of structure in the class of warm-blooded vertebrate animals, which are characterized by an oviparous generation, I was induced to suspect, after having ascertained how closely the Marsupiata approached birds in their mode of generation, that the brain might present in them some corresponding inferiority of structure, as compared with the placental Mammalia.

* Encycl. of Anatomy, p: 89.

"An attentive study of the manners of different marsupials in confinement, and an inspection of the exterior forms of the brain in some of the species, induced me to allude, in my paper on the Kangaroo, to an inferiority of intelligence, and a low development of the cerebral organ, as being the circumstances in the habits and structure of these singular animals which were most constantly associated with the peculiarities of their generative economy. I have since the most satisfactory confirmation of this coincidence, from repeated dissections of the brains of marsupials belonging to different genera, and although unable to explain how a brief uterine existence, and the absence of a placental connection between the mother and fœtus, can operate (if it be really effective) in arresting the development of the brain, yet it is a coincidence which has been so little suspected, and is so interesting in various points of view, that I believe the evidence of it will be acceptable both to the physiologist and the naturalist."

Fig. 40.

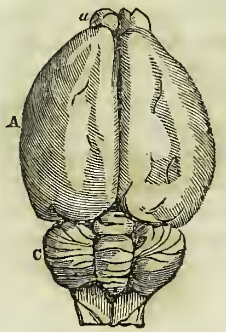


Fig. 41.

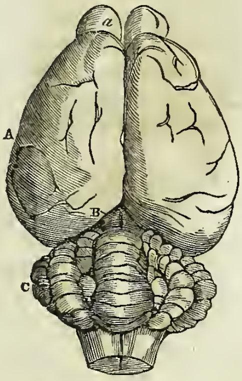


Fig. 40.—Upper surface of the brain of the beaver, reduced one-half. (Owen.) A. Cerebral hemispheres. *a.* Olfactory ganglion. C. Cerebellum.

Fig. 41.—Upper surface of the brain of the wombat, reduced one-half. (Owen.) A. Cerebral hemispheres. *a.* Olfactory ganglion. B. Optic ganglion. C. Cerebellum.

Mr. Owen compared, step by step, the brain of the Marsupial Wombat and the Rodent Beaver; and though these creatures are so alike in outward form and habits of life, that they have been classed in the same Order by some naturalists, he discovered this most important difference of organization—on the outward surface, the brain of the wombat appears more highly organized than that of the beaver, as it presents some appearance of convolutions, while the brain of the beaver is quite smooth (see figs. 40 and 41). But in the beaver the hemispheres of the brain are longer, and extend backwards further, so as to cover the optic tubercles, which they do not completely in the wombat.

On separating the hemispheres of the brain in the beaver, we bring into view a broad and distinctly fibrous commissure—the great transverse commissure or corpus callosum. This may be traced into the hemispheres on each side, as in the human brain (see fig. 42). On separating the cerebral hemispheres of the wombat, there is no such commissure: not only are optic tubercles and pineal glands uncovered

as in the beaver, but the optic thalami also. Instead of a broad corpus callosum, we perceive, situated deeply at the bottom of the hemispheric fissure, a small commissural medullary band (see fig. 43, *n*), passing in an arched form over the anterior extremity of the thalami, and extending beneath the overlapping interior or mesial surfaces of the hemispheres, which thus appear, as in the bird, to be wholly disunited. This band of fibres (*n*) is the analogue of the fornix. "As the great commissure is wanting," says Mr. Owen, "in the brain of the Great and Bush Kangaroos, the Vulpine Phalanger, the Ursine and Mangles Dasyures, and the Virginian Opossum, it is most probably characteristic of the marsupial division of Mammalia."

Fig. 42.

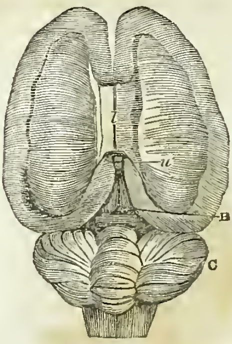


Fig. 43.

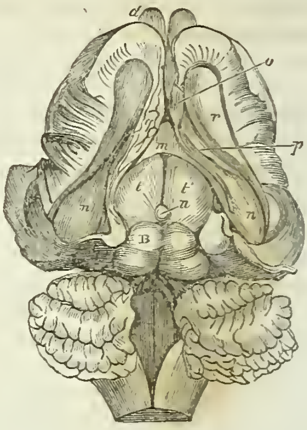


Fig. 42.—Brain of the beaver, with the substance of the hemispheres removed to the level of the corpus callosum: reduced one-half. (Owen.) B. Optic ganglia. C. Cerebellum. *l*. Corpus callosum. *u*. Pineal gland.

Fig. 43. Brain of the wombat, with the substance of the hemispheres removed to the level of the fornix. except on the right side, where part of the thin internal wall of the lateral ventricle is left; reduced one-half. (Owen.) B. Optic ganglia. *a*. Olfactory ganglia. *m*. Fornix. *n*. Hippocampus major. *o*. Anterior fibres of the tænia hippocampi connected with the anterior lobes of the hemispheres. *p*. Plexus choroides. *q*. Septum lucidum. *r*. Corpus striatum. *t t*. Optic thalami. *u*. Pineal gland.

It is stated in the last edition (1845) of Cuvier's Leçons, in reference to the commissural apparatus in the Marsupiata, that at the same time that the great transverse commissure diminishes, the anterior commissure increases to an enormous size; it is, in the brain of the kangaroo, four times larger than the anterior commissure in the brain of the ox, while the size of the brain itself is four times smaller.

Mr. Owen also gives drawings of two species of herbivorous and two of carnivorous Marsupiata, to show the indications of superior development which distinguish the brain of the herbivora, in the greater proportional development of the cerebrum, its convoluted surface, and the smaller proportional size of the olfactory tubercles. In all species, but especially the carnivorous marsupials, the greater relative size of the vermiform process is deserving of notice, as indicating the approach to the oviparous type of cerebral structure. It is associated with a corresponding diminution of the pons Varolii.

Mammalia Placentalia.—The lowest animals of the true Mammalia are the Rodent, or gnawing animals, such as the rat, rabbit, squirrel, &c., and to them we will now direct our attention.

The following description of the brain of the rabbit has been minutely given, because this animal is always easily to be procured, and because I am sure that whoever will take the trouble to dissect it, before attempting that of the human brain, will find his path much facilitated by the knowledge and the manual dexterity he will have acquired.

He will be prepared, too, to take a more correct view of the human brain, and his mind will be divested of many of those feelings of awe and mystery, which have unfortunately been hitherto so constantly associated with its structure.

When the upper part of the skull of the rabbit is removed, we observe that the cerebral mass consists of three grand divisions: the first and smallest of these comprises the olfactory tubercles; the second, the hemispheres; the third, the cerebellum; the other ganglia remain entirely concealed. The hemispheres are slightly marked on the surface, but not a tall convoluted.—(See fig. 44.) On separating the hemispheres, we find them connecting together by a band of medullary neurine, called in the human subject the great transverse commissure, or corpus callosum.

Fig. 44.

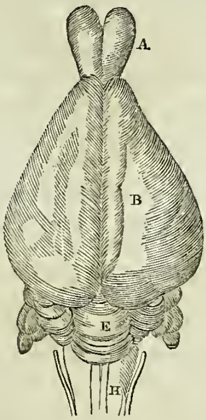


Fig. 45.

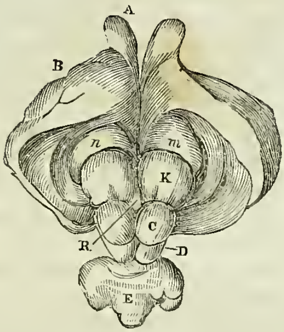


Fig. 44.—Brain of the rabbit, upper surface. A. Olfactory ganglion. B. Hemispherical ganglion. E. Cerebellum. H. Spinal cord.

Fig. 45.—Brain of the rabbit; hemispheres turned back, exposing the corpus striatum and optic thalamus on the right; the former on the left side covered by the fornix or longitudinal commissure. A. Olfactory ganglion. B. Hemispherical ganglion. C. Optic ganglion. D. Testes, or posterior optic ganglion. E. Cerebellum. K. Thalamus nervi optici. R. Pineal gland. *m.* Corpus striatum. *n.* Longitudinal commissure, or fornix.

If the great transverse commissure be now divided, and the hemispheres separated from each other, several parts of importance beneath it will be exposed (see fig. 45). Commencing from the posterior part, we observe just in front of the cerebellum four rounded bodies, the posterior (D) of which are small, not being more than a fourth part as large as the anterior (C). These four bodies are analogous to the single pair of optic tubercles in the bird, and in man are called the *tubercula quadrigemina*, or the posterior the testes, and the an-

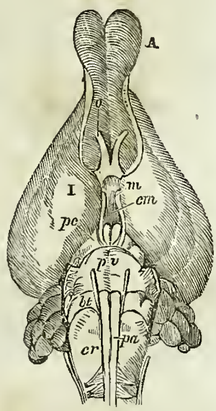
terior the nates. Immediately anterior to these bodies we find two other rounded projections, the anterior of which is the larger. The posterior (K) is formed by a body which, in the human brain, is known by the name of the *thalamus nervi optici*, but this is not the true optic ganglion, though it does receive some fibres from the optic nerve. This projection, though principally formed by the optic thalamus, is not solely formed by it; for covering the thalamus, we find a thin layer of medullary neurine, the outer edge of which corresponds to that of the thalamus, so that in this stage of the dissection the thalamus is not really exposed. This band of medullary neurine, *inferior longitudinal commissure*, consists of two sets of fibres; one set appears to correspond to the *tenia semicircularis* in man, lying between the thalamus and corpus striatum; the other comes from the under and back part of the brain. It rises up from this part, covering in its course a large internal convolution, the *hippocampal lobe—hippocampus major.* From this part, we find it passing forwards and inwards, and winding over the surface of the thalamus, and, running in front of it, dips down to the under part of the brain, forming the anterior pillars of the fornix, and terminates partly in that portion of the spinal cord which in the human subject is known by the name of the *crus cerebri*, and partly in the thalamus. The beautiful structure just described forms a communication between the anterior and posterior portions of the hemisphere of the same side, and runs along the course of the mesial line. In the brain of man this band has hitherto gone by the name of fornix, but I have named it inferior longitudinal commissure, as being more in accordance with its structure and probable function. If an incision extending in a direction forwards and outwards, be made, commencing at the optic ganglion, completely through this commissure, the optic thalamus will be exposed.

The projection which is immediately anterior to the thalamus is analogous to the corpus striatum of the human brain, a part that has received its name from the striated appearance it presents on a section being made of its substance; the cineritious neurine being deposited in striæ between the white fibres which are passing from the hemispheres to the anterior columns of the spinal cord. The corpus striatum and thalamus are, therefore, deposits of neurine, through which the component fibres of the anterior and posterior columns of the spinal cord pass in their course from and to the hemispheres, and have been characterized, I think advisedly, by Spurzheim, as ganglia. The corpus striatum should be entitled the anterior, and the thalamus the posterior, cerebral ganglion of the cord. Running near the edge of the thalami, towards the nates, are two white lines, which, turning off at a right angle to cross the mesial line, meet with a very small cineritious body, about the size of a pin's head. This little body is the pineal gland (R); the whole structure forms a commissure between the two opposite thalami, and may be called the *pineal commissure*. Situated immediately beneath the pineal gland, and between the thalami, is a transverse band, which in the rabbit is not much thicker than a thread, called the *posterior commissure*, immediately in front of which is a middle band of cineritious neurine, and still further forward is another; these are respectively called the *anterior* and

middle commissures of the brain, in distinction to the posterior commissure.

The hemispheres having been completely turned back in the performance of this dissection, the student cannot fail to observe that they form a sort of cap to the anterior and posterior cerebral ganglia of the cord, covering them something in the same way that the head of a mushroom does the footstalk; the space left is the lateral ventricle. The admirable contrivance by which the immense quantity of neurine composing the large cerebral ganglia in these animals is lodged in such a circumscribed space as the cranial cavity, must be interesting to the reflecting student.

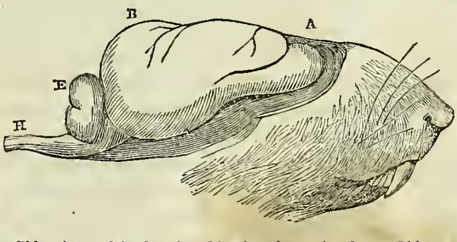
Fig. 46.



Brain of the rabbit, under surface (Leuret). A. Olfactory ganglion. I. The inferior part of the internal convolution or lobe of the hippocampus, to which phrenologists have appropriated the organ of alimentiveness. *o*. Optic nerve. *m*. Common motor nerves of the eyes, or motores oculorum. *c m*. Corpus mammillare. *p c*. Crus cerebri. *p v*. Pons varolii. *b t*. Corpus trapezoidum. *p a*. Anterior pyramidal body. *c r*. Corpus restiforme.

If the brain be now removed from the skull, reversed so as to expose the under surface (see fig. 46), and the eye carried along the spinal cord, it will be observed that the cord becomes of nearly double the thickness it possessed within the vertebral canal. This thickened portion of the cord is called the *medulla oblongata*, and contains within its substance the olivary bodies, the pneumogastric ganglia, and the posterior pyramidal or auditory ganglia. Crossing the medulla oblongata transversely is a band of medullary neurine, which, running from one side of the cerebellum to the opposite, forms the commissure of that part, and is usually known by the name of the *pons Varolii* or *tuber annulare* (*p v*). The spinal cord beyond this commissure splits into two portions, which, running to the two corresponding hemispheres, are called the *crura*, or legs of the brain (*p c*). Between them is the collection of cineritious neurine called the *tuber cinereum*, and immediately anterior to it the commissure of the optic nerves. The hemispheres appear divided into two lobes on each side, and the fissure of separation is called the *fissura Sylvii*. The commissure between the olfactory ganglia and the hemispheres is of considerable width, consisting of cineritious and medullary neurine, but it is short when compared with that of the carp and whiting.

Fig. 47.



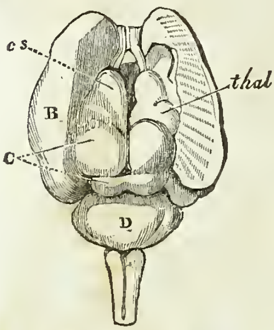
Side view of the head and brain of a squirrel. A. Olfactory ganglion. B. Hemispherical ganglion. E. Cerebellum. H. Spinal cord.

The under part of the hippocampal lobes are now distinctly seen, and the great size should be observed.

In the porcupine and agouti the auditory ganglia are of great size. In the squirrel the hemispheres are smooth (fig. 47), the olfactory ganglia large, as also

the cerebellum, so that, on a lateral view, the whole encephalon bears much resemblance to that of the bird: when this brain is dissected (fig. 48), the small size of the hemispherical ganglia, in proportion to the other cerebral ganglia, is well seen.

Fig. 48.



Brain of the squirrel: hemispheres separated, exposing the cerebral ganglia of the cord. B. Hemispherical ganglion. c. Optic ganglion. *a.* Testes, or posterior optic ganglion. D. Cerebellum. *thal.* Thalamus nervi optici. *cs.* Corpus striatum.

Next to the Rodentia, in the class Mammalia, is the order Edentata, or toothless animals. This order includes the sloths, and the extinct genera of gigantic sloths, such as the megatherium. The brain is simple, and affords no peculiarities of physiological interest.

We next come to the order *Ruminantia*, of which the Sheep is a familiar illustration.

The facility of procuring the brain of the sheep, and the slight cost at which multiplied dissections of it may be made, induce me to bring it under the notice of the student, as affording another characteristic link in the chain of cerebral complication, from the lower to the higher tribes of creation, and its termination in man. Investigations of this kind, indeed, ought to be pursued through as extensive and varied a series of animals as can be procured; each offers some peculiarity well worthy of attention, and all confirm the important truth in the science of zoological anatomy, without which human anatomy is but a limited and unsatisfactory pursuit, that every one of the organs through the whole of the animal kingdom is constructed on one uniform and simple plan. The brain of man, which had so long been, and even now remains, an obstacle in the path of the teacher and student who restrict themselves to the limits of human dissection, may be shown to have been formed with the same attention to the beautiful simplicity which distinguishes all the varied forms of organized existence. The minute description which has been given of the anatomy of the brain of the rabbit, makes it unnecessary to dwell with the same attention to detail on each point in that of the sheep; so that I shall merely mention those particulars in which they differ, and thus point out some others in which the brain of the sheep approaches more in its structure to that of man.

The upper surface of the cerebral mass of the sheep presents, on each side, three divisions—the olfactory ganglion, the hemispherical ganglion, and the cerebellum (see fig. 49). The olfactory ganglia may be seen in front of the hemispheres, as in the rabbit; for although the hemispheres have increased so much in size, still they do not yet completely cover or conceal them—the olfactory ganglia being also very large. The hemispheres are not merely of larger relative dimensions, but their shape is altered: they have lost the pyriform character they presented in the rodent animal, and have assumed more of the oval form which they possess in the human being. Their surface, instead of being smooth, is much convoluted, looking exactly as if it were formed by the folding

up a soft but tenacious substance. The cerebellum is not much changed in appearance; it is only somewhat larger in proportion to the cerebrum.

Fig. 49.

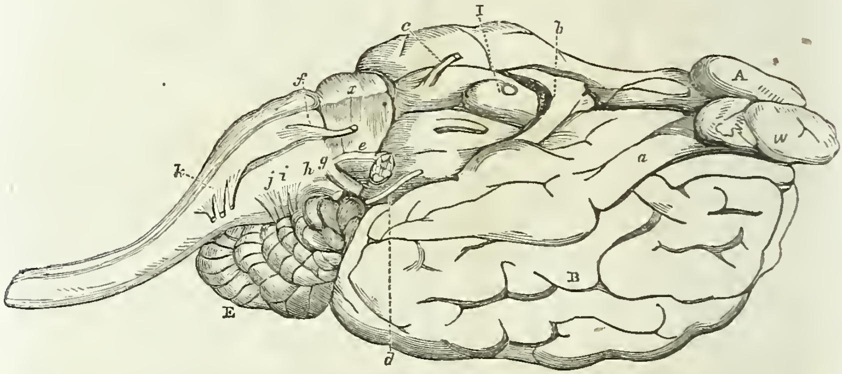
Brain of the sheep, natural size. (Leuret.) A. Olfactory ganglion. B. Hemispherical ganglion. E. Cerebellum.

The great transverse commissure has increased in accordance with the greater development of the hemispheres; and when we divide it in the middle, and turn either half back, in order to expose the optic tubercles, the thalami and corpora striata, we find the latter appearing as if they were placed within a circumscribed cavity, so much have the hemispheres increased in size in every direction. The space which is left between the corpora striata and thalami, and the under surface of the hemispheres, has been described in the human brain, under the name of *lateral ventricle*, as if it were a cavity or chamber scooped out of the substance of the brain. But it must be evident to every one who has followed the gradual development of the hemispheres from before backwards, that this space is merely a fissure analogous to those fissures which are met with on the surface of the brain between opposing convolutions, the *fossæ digitatæ*. We find, in fact, that the spaces denominated *lateral ventricles* are the necessary effect of the drawing back, if I may so express it,

of these extensive surfaces of neurine covering the crura cerebri or anterior productions of the medulla oblongata. By the addition of the anterior and posterior cerebral ganglia of the cord (the corpus striatum and thalamus), the structure comes to bear a considerable resemblance to a head of cauliflower included within its capsule of leaves, or, as I have said elsewhere, to the nodulated head of a walking-stick, over and around which a piece of cloth has been tied, and then reflected forwards upon itself.

The edge of the fornix or longitudinal commissure may be seen lying in the groove between the anterior and posterior cerebral ganglia; the posterior ganglion, or thalamus, being, however, so completely covered that it cannot be seen until the commissure is completely divided and reflected outwards. If the hemispheres be now turned forward, the cerebral ganglia on both sides will be exposed, with the pineal commissure, and tubercula quadrigemina. Crossing the fissure between the posterior cerebral ganglia, (absurdly called the third ventricle,) the commissura mollis, or middle commissure, will also be brought into view.

Fig. 50.

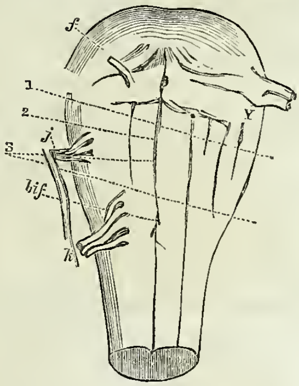


Brain of the sheep removed from the skull, and lying on its upper surface, size of life. A. Olfactory ganglion. B. Hemispherical ganglion. E. Cerebellum. I. Tuber cinereum *a.* Olfactory commissure. *b.* Optic nerve. *c.* Third nerve *d.* Fourth nerve. *e.* Fifth nerve. *f.* Sixth nerve. *g.* Seventh. facial. *h.* Eighth, auditory. *i.* Ninth, glosso-pharyngeal. *j.* Tenth, par vagum. *k.* Eleventh, lingual. *x.* Pons Varolii.

On the base or under surface of the brain we observe that the olfactory ganglia or tubercles (see fig 50) are very highly developed; they are, in fact, nearly three times as large as those of the human subject, a size which appears to correspond with the complicated structure of the nose in this animal, and to be in proportion to the acuteness of their sense of smell. The olfactory commissures are short and thick, scarcely a line's breadth being left between the tubercle and the point where they are united to the under surface of the hemispheres. These commissures extend backwards to the hippocampal lobes, which is some way further than the point where they are first attached to the surface of the cerebrum. We need go no further to prove the absurdity of *still* denominating analogous parts in the human being, nerves. The olfactory ganglia themselves are composed of medullary and cineritious neurine.

The pons Varolii (x), or tuber annulare of Willis, is small in the sheep compared with the same part in man: here it is not more than three lines in breadth. The corpora mammillaria are united so as to appear like a single body. The tuber cinereum is not particularly distinct; through its centre we find a sort of funnel-shaped tube passing, called the *infundibulum*, which joins a rounded structure situated on the sphenoid bone, called the *pituitary gland*. The character or analogy of the last-mentioned parts is extremely obscure, and there is a mystery here which has not yet been unraveled. The medulla oblongata, like that of the rabbit, is very thick in comparison with the spinal cord.

Fig. 51.



Medulla oblongata and pons Varolii of the sheep. Nos. 1, 2, and 3, with the lines, mark the sections, the surfaces of which are exhibited in the next figure (52). The lines are not drawn at right angles to the cord, as they should be. *f.* Sixth nerve. *j.* Tenth, par vagum. *k.* Eleventh, lingual. Y. Corpus trapezoidum.

The anatomy of the medulla oblongata presents many points of interest. But in order to understand them it is necessary to anticipate a little. If the reader will refer to my description of the part in man, he will find that the surface, viewed anteriorly and externally, presents those projections named, from their shape, the corpus pyramidale, the corpus olivare, and corpus restiform. The corpus pyramidale is part of the anterior column of the cord, which must not be considered an isolated body or ganglion, but merely an appearance caused by the decussation which the fibres of the column take at this part. They do not descend perpendicularly on the same side, but they cross over to the opposite side, decussating with their fellows; the corpora pyramidalia in the sheep are small. The corpus olivare is a true ganglion—a collection of cineritious neurine. The corpus restiforme contains a ganglion which is connected with the pneumogastric nerve; it is the homologue of the branchiogastric ganglion in fish. It may be called the pneumogastric or restiform ganglion.

If the posterior surface of the medulla is examined, a fourth projection may be seen projecting on each side of the mesial line, of a pyramidal form—the *posterior pyramidal bodies*, or *auditory ganglia* (F F).

Thus it will be found that the medulla oblongata contains on each side *three* ganglia, while each vertebral section of the spinal cord only contains *two*, the anterior and posterior peaks of gray matter.

The distinction between these last-named ganglia is better seen in some of the lower Mammalia, after making a transverse section, than in man. I believe that in all the Mammalia, except the monkey, the elephant, and the porpoise, the corpora olivaria do not project on the surface, and hence the assertion by some anatomists, that they are wanting in most of the Mammalia.

Longet says, p. 390,* "The olivary bodies attain their highest deve-

* Anatomie et Physiologie du système Nerveux de l'homme et des animaux Vertébrés,

lopment in the human species; it is often impossible to perceive these eminences in other Mammalia."

"Having carefully examined," says Rolando, "the place where these eminences ought to be, I can assert that they are not to be met with in the ox, pig, sheep or goat."

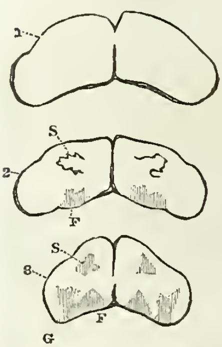
Carus affirms "that they are wholly absent in most Mammalia, or at least that they do not present the arborescent appearance of white and gray neurine which they do in man."

I have found these ganglia in the sheep, horse, calf and cat, and I have no doubt that they exist in all Mammalia.

"Gall," says Longet, "has certainly exaggerated their volume in the calf; they are sufficiently apparent in the apes, but especially in porpoises and in the dolphins."

In the sheep the corpora olivaria do not project on the surface. They are best detected by a transverse section; and they will be found, not on the side of the pyramidal bodies, but behind (see fig. 52); s represents the appearance they exhibit. It is taken from a drawing which I made with Mr. Grainger. We afterwards examined it under the microscope, and found the ganglionic corpuscles very beautifully distinct. Its exact longitudinal extent I cannot assert, but there was no appearance of it in a section made just above s, No. 3; fig. 52 exhibits what I believe is its inferior extremity. In the human subject they are much larger, though the neurine is folded into a small space, but if extended it would occupy nearly one inch in breadth. The auditory and pneumogastric ganglia are also very distinct (same fig., F and G). Finally, there is an appearance on the surface of the medulla to which there is nothing analogous in the human brain. This is produced by a transverse fibrous band running just below, and parallel to, the pons Varolii, from the restiform bodies to the edge of the anterior columns (see fig. 51): Y is called the *corpus trapezoidum*. It is met with in all Mammalia, except the ourang-outang, chimpanzee, and man.

Fig. 52.



Three sections of the medulla oblongata of the sheep.—See fig. 51. F F. Auditory ganglion. G. Pneumogastric ganglion. S S. Olivary body.

The cerebral nerves take precisely the same origin in the sheep as in the human subject, and need not, therefore, be dwelt upon in this place; although in dissecting the brain of the sheep, reference may be very advantageously made to the base of the human brain for assistance in discriminating several of the particular pairs of nerves.

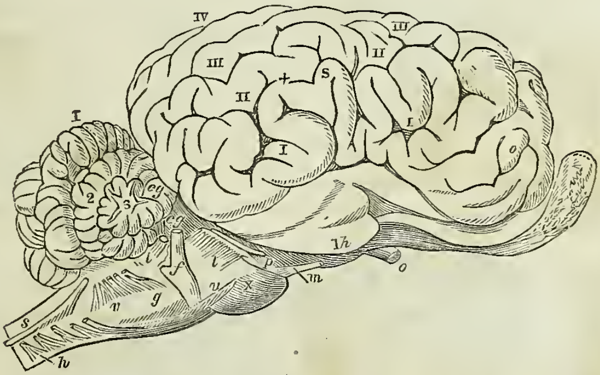
We have now seen enough of the anatomy of the brain of the lower animals to understand how we ought to study it in man; we have traced it from a most simple form up to what would have appeared a very complex one if we had not seen all the connecting links. The study of

par F. A. Longet, Lauréat de l'Institute de France, Académie des Sciences, Doct. en Médecine de la Faculté de Paris, Prof. d'Anatomie et de Physiologie, Chirurgeon de la Maison Royale de Saint Dennis, &c., 1842.

these links must assist us in the study of the human brain. In a mere anatomical point of view we might abandon our comparative anatomy and proceed at once to man; but in a physiological and philosophical point of view we shall find it interesting to glance at the characteristic features of the brains of those Mammalia which remain undescribed between the Ruminantia and the human race.

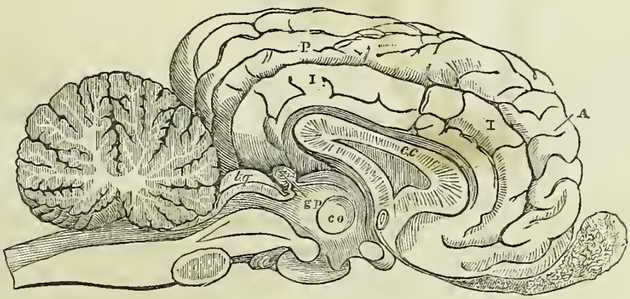
The *Pachydermata* or thick-skinned animals are the next in order, of which the Horse is our most familiar example; fig. 53 is taken from

Fig. 53.



External surface of the brain of the horse, reduced one-half. (Leuret.) s. Fissura Sylvii, which is bifurcated. 1, II, III. Those figures which are placed before the fissura Sylvii indicate each of the anterior convolutions; and I, II, III, IV, behind, indicate the four posterior convolutions. +. Point of re-union of the posterior convolutions I and II behind the fissure of Sylvius. o. Supra orbital convolution. 1 *h*. Hippocampal lobe, or inferior projection of the internal convolution. *c g*. Corpus geniculatum. 1, 2, 3, indicate the three lobes of the cerebellum. *e*. Olfactory ganglion. *o*. Optic nerve. *m*. Third pair. *p*. Fourth ditto. *t*. Fifth ditto. *u*. Sixth ditto. *f*. Seventh, facial. *l*. Eighth, auditory. *g*. Ninth, glosso-pharyngeal. *v*. Tenth, par vagum. *h*. Eleventh, lingual. *s*. Twelfth, spinal accessory. X. Pons Varolii.

Fig. 54.



Longitudinal section of the brain of the horse, through its centre, showing its internal surface, reduced one-half. (Leuret.) A. Anterior convolution. P. Posterior ditto. I. Internal ditto, surrounding the corpus callosum, united to the anterior convolution before, and posteriorly and inferiorly to the hippocampal lobe. *e*. Olfactory ganglion. *c c*. Corpus callosum divided in the centre. *c o*. Commissura mollis. *g p*. The letters are on the optic thalamus, the line leads to the pineal gland. *t q*. Optic tubercles; behind these is the divided cerebellum, exhibiting the arbor vitæ.

Leuret. At one glance the student will perceive that the brain is of a high character. (The drawing is reduced one-half.) The cerebrum is large, and the convolutions are numerous. It is rounder and more elevated than that of the ox, though in both there is more brain anterior to

the corpus callosum than behind it. It covers the tubercula quadrigemina and a part of the cerebellum. The internal parts are the same as in the sheep. The arrangement of cineritious and medullary neurine in the cerebellum is the same as in man. A perpendicular section exhibits the appearance called the arbor vitæ, and shows an immense surface of cineritious neurine. The olfactory ganglia are of great size, as also their commissures and the hippocampal convolutions. The medulla oblongata is large (see fig. 55). The pyramidal eminences are distinct; there is

Fig. 55.

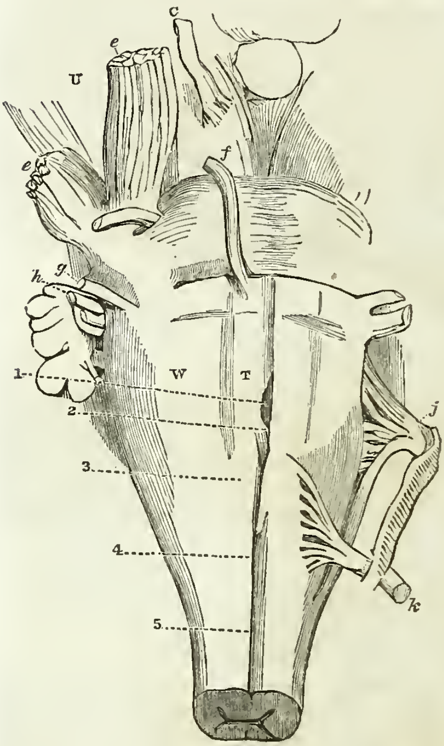


Fig. 56.

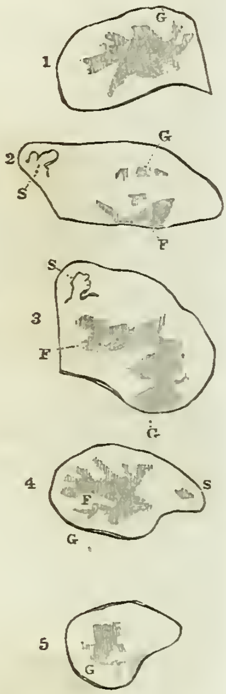


Fig. 55.—Medulla oblongata of the horse. Figures the same. The lines are numbered to indicate the sections exhibited in fig. 56. No. 2 impinges on the bifurcation of the anterior pillars. T. Corpus pyramidale. W. Corpus restiform. U. Crus cerebri. *c.* Third pair of nerves. *e.* Fifth ditto. *f.* Sixth ditto. The line crossing the medulla transversely below the root of this nerve marks the lower edge of the corpus trapezoidum. *g.* Seventh, facial. *h.* Eighth, auditory. *j.* Tenth, par vagum. *k.* Eleventh, lingual.

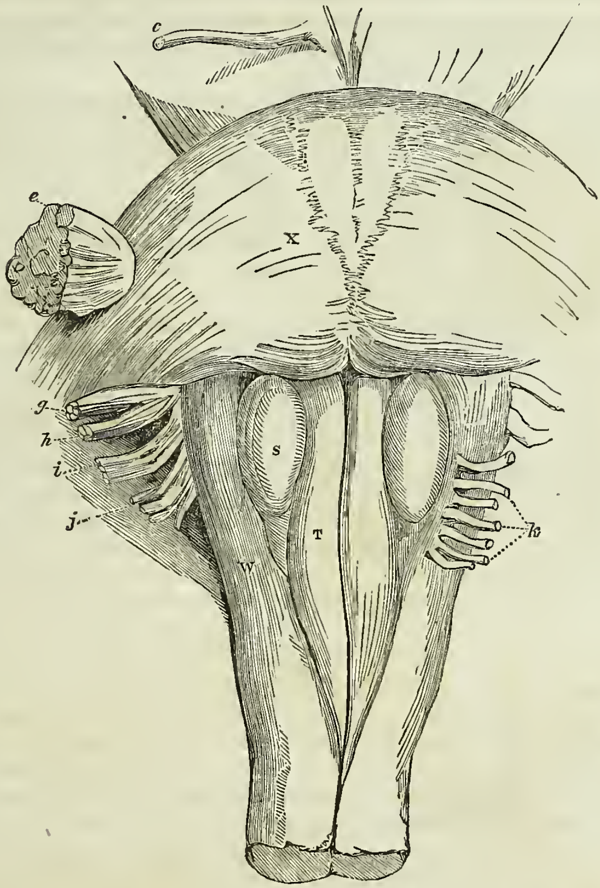
Fig. 56.—Sections of the medulla oblongata of the horse. For position, see fig. 55. Nos. 1, 4, and 5 have been placed by mistake with the inner or mesial edge of the section to the right instead of to the left, as in Nos. 2 and 3. G. Pneumogastric ganglion. F. Auditory ganglion. S. Olivary body.

no appearance of corpora olivaria on the surface, but a section reveals them clearly. This position, as compared with those in the human being, is curiously altered (see fig. 56, Nos. 2 and 3). This fact is to me a convincing proof that they are imbedded in the motor tract, and that they do not form any line of physiological demarkation. I have taken a great deal of pains to work this matter out, and ascertain what is the homology of these bodies. The conclusion I have arrived at is,

that they are the ganglia of the lingual nerves, and that the great extent of cineritious neurine which exists in them in man has relation to the multiplied movements of the organ of speech.

There are objections to this theory, and among others their great external size in the elephant (see fig. 57). In this figure, the great pro-

Fig. 57.



Medulla oblongata of the elephant; sketched from a preparation in the College of Surgeons. S. Corpus olivare. T. Corpus pyramidale. W. Corpus restiform. X. Pons Varolii. *c*. Third pair of nerves. *e*. Fifth ditto. *g*. Seventh, facial. *h*. Eighth, auditory. *i*. Ninth, glosso-pharyngeal. *j*. Tenth, par vagum. *k*. Eleventh, lingual.

jection they form on the surface of the medulla is very well shown; and it is most likely that this projection is caused by a great quantity of ganglionic neurine within: but without a section this cannot be positively asserted. Again, their large size in an animal whose intelligence approaches nearer to that of the human being than that of any of the lower animals, is curious and interesting. The olivary bodies are very distinct in the apes; but in some Carnivora, as the bears, they are not so well formed; in others, as the lynx, badger, and seal, the internal border is

confounded in their whole length with the pyramidal bodies, and only distinguishable by the origin of the twelfth pair of nerves. (Cuvier, Leçons.)

There is a preparation of the brain of the elephant in the Museum of the College of Surgeons, 1331, but it is not sufficiently dissected to render its internal anatomy distinct. Mr. Owen gives an account of it, and from that the following is taken. It is an interesting account, and confirms an opinion I advanced many years ago, that the hemispherical ganglion is *positively* not relatively larger in man than in any other animal.

The absolute size of this organ in the Asiatic elephant exceeds that of man. But the proportion which the cerebrum bears to the rest of the brain, and especially that part of the hemisphere which forms the roof and sides of the lateral ventricle, is much less.

"The hemispheres are broad and short, with a considerable development of the natiform protuberance. The convolutions are comparatively small and numerous. The anfractuosities are also deep, extending in some cases more than two-thirds of an inch into the substance of the brain. The hippocampus is comparatively smaller than in the ass, and the corpus striatum larger. The ventricle is continued into the olfactory bulb. The cerebellum is of considerable width, and its surface increased by numerous and complex anfractuosities. The tuber annulare corresponds in size to the development of the lateral lobes of the cerebellum. The corpora olivaria are remarkably prominent. The olfactory nerves and the fifth pair, which supply the proboscis, are remarkable for their prodigious size; whilst the optic nerves, and those which supply the muscles of the eye, are as remarkable for their small size."

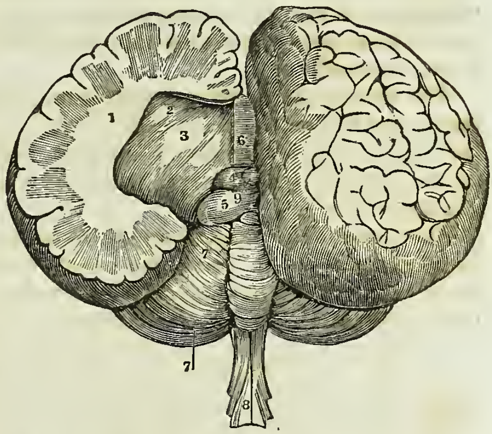
The brain of the Cetacea, which form the next group in the animal kingdom, must now engage attention. Of this class the porpoise affords the most convenient illustration. This creature, which to the vulgar is no more than a large fish, the enlightened physiologist admits into the same grand division of the animal kingdom to which man himself belongs. Bringing forth its young in a state requiring, long after birth, the protecting care of the mother, higher intellectual endowment is implied than we can expect in fishes and reptiles, whose spawn is generally abandoned by the parent as soon as it is shed, and in accordance with these manifestations of higher powers we find the cerebral mass developed upon the same plan, and presenting nearly the same appearances and arrangement of parts, as some of the most perfect of the terrestrial Mammalia, and even as the brain of man himself.

Looking at the superior part of the cerebral mass of the porpoise, as represented in fig. 58, we observe two divisions, the cerebrum (1) and cerebellum (7); the whole surface is convoluted as in the human brain, and although the convolutions are smaller, the sulci between them are of considerable depth; its shape is peculiar, from its great lateral width as compared with that of the human being or sheep, for the cerebral hemispheres taken together are even longer from side to side than from before to behind. The dimensions of the cerebellum are great in comparison with those of the cerebrum, the whole cerebellum bearing a proportion to one hemisphere of the cerebrum as two to two and a half.

This is owing to the great size of the lateral lobes: the middle lobe or processus verniformis is small, as will be seen by fig. 58. The posterior lobes appear to be wanting, as in the sheep, by which the cerebellum is left partly uncovered.

The great transverse commissure or corpus callosum (6) is strikingly short from before backwards, measuring a little more than one-fourth of the whole length of the hemisphere, if we except that portion which curves downwards in front, and which is about a third of the length of the horizontal portion, so that the tubercula quadrigemina or optic tubercles (4 and 5) are entirely uncovered by it, and on removing the arachnoid and pia mater, are to be observed between its posterior edge and the cerebellum, nearly a third larger than those in the human brain; the posterior pair, or testes (5), are nearly double the size of the anterior or nates (4).

Fig. 58.



Brain of the porpoise, half of the left hemisphere removed, opening the lateral ventricle. 1. Section of the left hemisphere, exposing the left ventricle, containing—2. Corpus striatum, or anterior cerebral ganglion; the line between this and the next is not very distinct. 3. The posterior cerebral ganglion or optic thalamus. 4. The anterior quadrigeminal bodies, optic tubercles, or nates. 5. The posterior quadrigeminal bodies, optic tubercles or testes. 6. Great transverse commissure, or corpus callosum. 7. Cerebellum. 8. Spinal cord. 9. Pineal gland.

In the brains of the Mammalia we have already examined, the Rodentia, Ruminantia, Pachydermata, we found the relative size of the optic tubercles the same as in man, viz., the anterior larger than the posterior; but generally in the Cetacea and Carnivora the posterior are the largest. The kangaroos resemble the herbivorous Mammalia in this respect.

The pineal gland (9) is small but distinct, as well as its commissure. A perpendicular section having been made through the transverse commissure a little to the left side of the mesial line, and a horizontal one carried through one of the hemispheres on a level with it, the thalamus nervi optici (3) and corpus striatum (2) are exposed, the latter scarcely a fourth part as large as the former. The fornix, which is small, has been divided, and with the exception of its anterior pillars and the septum lucidum, removed in making the above section. There is no posterior cornu to the lateral ventricle.

The plexus choroides is very peculiar, being transversely folded, like the branchiæ of a bivalve (see Preparation 1332, College Museum).

Has this arrangement of blood-vessels special relation to the brain, or is it merely a part of those arterial plexuses which are found so large in the thorax, and exist in the spinal canal and about the head, as reservoirs

of arterial blood for the animal when diving? A similar arrangement exists in the whale.

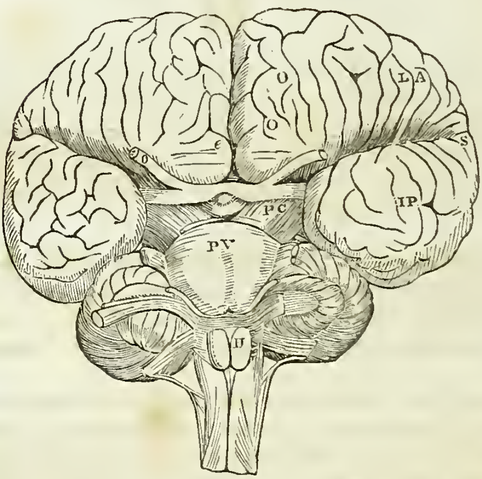
Base of the Brain (see fig. 59).—The fissura Sylvii (s) is deep; the middle lobe very large, and projecting more than in the sheep. But the hippocampal convolutions are much smaller, and do not present the same distinctness.

The pons Varolii or commissure of the cerebellum (P V) is large in proportion to the whole cerebral mass, and is about the same size as this part in man, according with the great development of the lateral lobes of the cerebellum.

The medulla oblongata presents more points of interest and instruction than any other part. In the first place it is more than double the size of the spinal cord, a circumstance which partly depends on the large size of the corpora olivaria, and partly on the magnitude of the posterior pyramidal bodies.

The corpora olivaria (H) are so amazingly developed, that, instead of being separated from each other, as in the human being, by the corpora pyramidalia, they overlap and cover these so completely as even to come into contact with each other in the median line (see fig. 59). The lingual nerves are not of proportional size, but the pneumogastric nerves are about double the size of those of man. If the corpora olivaria be carefully elevated, the anterior columns of the spinal cord will be seen decussating beneath and posterior to them.

Fig. 59.



Base of the brain of the porpoise. (Leuret.) This figure exhibits the absence of olfactory nerves, the large size of the pons Varolii, also the olivary bodies, and their juxtaposition on the mesial line. O O. Orbital convolution. P. C. Crus cerebri. P V. Pons Varolii. S. Fissura Sylvii. L A. Anterior portion of the antero-posterior convolutions. I P. Posterior ditto. H. Olivary bodies. *o*. Optic nerve.

The arrangement of the fibres of the anterior and posterior columns, as regards their course towards the cerebellum, and the share they take in the formation of the corpora restiformia, is perfectly identical with the disposition of the same parts in the human brain, which will be found described so fully further on, that it will be unnecessary to dwell upon it here. The accordance is, nevertheless, extremely interesting as confirming those views I have advanced on the subject of the communications between certain parts of the medulla oblongata and the cerebellum.

Origin of the Nerves in the Porpoise.—The olfactory nerves are entirely absent.

The optic are smaller than those of man; their origin is the same.

The 3d, 4th, 5th, and 6th, are also exactly similar.

The 7th, or facial, is the same both in size and origin.

The 8th, or auditory, is nearly double the size of that in the human being.

The 9th, or glosso-pharyngeal, is large.

The 10th, or par vagum, is at least double the size it presents in man.

The spinal accessory is rather small. Its origin is the same as in man.

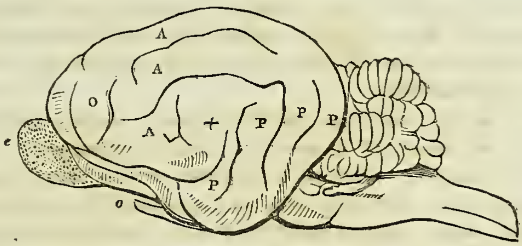
The 11th, or lingual, is rather large. Its origin is from the anterior columns of the cord close to the corpora olivaria.

In the different genera of *Whales*, John Hunter tells us that the brain differs much in size. The thalami are large, but the corpora striata are small. The fibrous neurine of the hemispheres may be distinctly traced through the inner layers of the hemispherical ganglion.

In the piked whale the whole brain was found to weigh four pounds and ten ounces.

The *Carnivora* form the next group in the animal kingdom, consisting of the bears, martens, dogs, cats, and seals. The number of ganglia and commissures constituting the encephalon of these animals is the same in all. There is no great peculiarity as regards their relative size. In the common cat (see fig. 60), the olfactory ganglia (*e*), as we might expect,

Fig. 60.



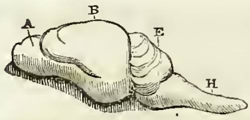
Side view of the brain of the common cat. (Leuret.) *e*. Olfactory ganglia. *o*. Optic nerve. A A A. Anterior portion of longitudinal convolutions. P P P. Posterior of ditto. S is opposite the fissura Sylvii; a line from S divides these two sets of convolutions. +. Union of the two. O. Orbital convolution.

are enormous. The hippocampal lobes are also large. The hemispheres cover the optic tubercles, and partly overlap the cerebellum. The hemispherical ganglion is much convoluted. The convolutions are described further on. The anterior and posterior quadrigeminal bodies are of nearly equal size, the anterior being rather the longest from before backwards. "In the lion the posterior, though smaller in longitudinal diameter, are broader, and rise above the level of the anterior pair."—(Owen.) In the seal the olfactory ganglia are small, but not absent, as in the Cetacea, though the form of the brain resembles in its roundness that of these creatures. The hemispheres do not entirely cover the cerebellum, which is large, especially its lateral lobes. The corpora olivaria maintain the same central position as in the porpoise, but they do not project on the surface. The *corpus trapezoidum*, that oblong portion of the medulla oblongata running transversely inferior and parallel

to the pons Varolii, between the fibres of which facial and auditory nerves emerge, is of remarkable size in all the genus *Felis*.—(Owen.)

In the group *Insectivora*, hedgehogs, moles, &c., the brain retrogrades, as will be seen by referring to fig. 61, which represents the brain of the hedgehog. The olfactory ganglia (A) are enormous compared with the hemispheres. The hippocampal lobes are very large, corresponding with the olfactory ganglia. The hemispherical ganglia are quite smooth and free from convolutions; the cerebellum is large and well developed.

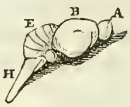
Fig. 61.



Side view of the brain of the hedgehog. A. Olfactory ganglion. B. Hemispherical ganglion. E. Cerebellum. H. Spinal cord.

The *Cheiroptera*, or hand-winged animals, the bats, come next. The brain of the bat (fig. 62) closely resembles in outward appearance that of the bird. The olfactory ganglia (A) are larger, but the hemispheres (B) are very small and smooth; the cerebellum is peculiarly large.

Fig. 62.



Side view of the brain of the bat. A. Olfactory ganglion. B. Hemispherical ganglion. E. Cerebellum. H. Spinal cord.

Next to the Cheiroptera below, and to Man above, we have the Quadrumana, the lemurs, baboons, apes, and monkeys. No general observations will describe the characteristics of the brain in this class beyond what apply to the Mammalia generally: for the brain of the highest, namely, the chimpanzee, approaches nearly to that of man; while some of the lowest appear to be little raised above those of the rodents and insectivora, as regards the convolution of its surface.

Mr. Owen, in his paper on the Marsupiata, already referred to, gives a drawing of the brain of a monkey (*Midas rufimanus*); the surface of whose brain is smooth, with the exception of one short longitudinal fissure extending but a short distance on the hemisphere from before backwards: at the same time it must be stated that this brain is above that of the rodents, &c., inasmuch as it covers the cerebellum.

The outline of the brain of Mammalia, as viewed from above, presents three principal varieties. In one it is almost circular—this includes the ourang outang, the seal, and the porpoise. In another it is oval, more or less elongated, as in the lion, beaver, and sheep. While in a third it is almost triangular or heart-shaped, the anterior lobes being remarkably narrow, as in the ferret, in the opossum, and in the rabbit. The forms have no relation to the different orders of the Mammalia, as the examples which have been mentioned show.*

There are a few parts of the encephalon on which I have thought it well not to say much in the description of the brain individually, but which it may be well to consider collectively.

Corpora Geniculata.—The tubercles which will be pointed out in man as forming a third pair, under the name of the corpora geniculata interna, become in monkeys, in dogs, and in other Carnivora, as large as those

* Cuvier, Leçons, 2d ed., 1845.

of the other pairs; but they are small or scarcely visible in the Ruminantia. They are very large in the horse, and always joined to the testes by a strong fibrous fasciculus, which appears to pass under the optic nerve and terminate in the optic thalami. In the monkeys, especially in the ourang outang and the baboon, we find the corpora geniculata interna also receiving a fasciculus from the nates, and giving out a root which runs low enough to unite itself with the principal cord of the optic nerve.

The corpora geniculata externa are much less constant than the interna, and their projection, already much effaced in the monkey, is no longer distinguished in the other classes from the projection of the optic thalamus under the ribbon of the nerve which conceals it.

Optic Thalami.—The size of these ganglia, the optic thalami, appears to be in direct relation with the size of the folds of the hemispheres. This is especially observable in the dolphin, where the hemispheres are of considerable size and thickness.

The *pineal gland* does not present any remarkable difference. It is sometimes elongated into a cylinder, as in the ox and the seal; sometimes triangular, prismatic, or cordiform, as in the sheep and the horse; or conical, as in the monkey: it is generally small in the Carnivora. Its fasciculi, from their origin on the upper surface of the optic thalami to the anterior commissure, may be distinctly traced. In the opossum, the fasciculi at the origin of the gland are large, and form a projection on the superior edge of the optic thalami. Many anatomists affirm to never having met with earthy concretions in any animal, analogous to those which are seen in the pineal gland in man.

Corpora Striata.—These bodies scarcely differ, in all the Mammalia, except in size; they are separated from the optic thalami by a very marked, and sometimes by a very deep, furrow, in which are lodged the *tænia semicircularis* and the pillar of the fornix, and their size is in general very similar to that of the optic thalami. In the dolphin, however, the disproportion is considerable; the corpus striatum is much less prominent and less voluminous than the optic thalamus.

Corpus Callosum, Fornix, and Hippocampal Lobe.—The corpus callosum and the fornix, like the striated bodies, do not differ much in size. The hippocampal lobes are generally larger in proportion in Mammalia, but their surface does not present the same swollen appearance as in man. The corpus callosum, in some instances, seems to be developed, as regards its size, in relation to the corpus striatum; as we have already seen in the brain of the porpoise, which has large hemispheres, a proportionally small and thin corpus callosum, and a very moderately-sized corpus striatum.

Ventricles.—There is no digital cavity in the lateral or anterior ventricles, except in man and the apes. Its presence depends on that of the posterior lobes; but in the seals and dolphins, where the posterior part of the hemisphere is considerable, it descends into the temporal fossa, thus exhibiting a rudiment of the digital cavity in the brain of man.

The lateral ventricle, in most Mammalia, is continued anteriorly into the hollow tube of the olfactory commissure, the third and fourth ventricles not presenting any remarkable difference.

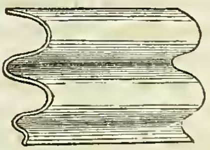
The mammary tubercles are often very distinct, as in the Callitrix, one of the squirrel-monkeys, the lion and the lynx: they are more frequently blended into one, as in the hyrax, stag and lama.*

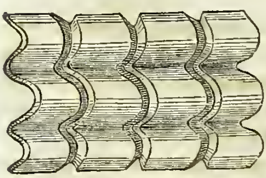
It has been already explained that the convoluted hemispherical ganglia are the parts with which the intellectual powers are more immediately connected; and as the ganglia increase in size, they become altered from mere rounded points, like peas, to folded surfaces. The principal change which we have to observe in tracing the form of the brain from the Rodentia up to Man, is in the relative proportion of the hemispherical to the rest of the cerebral ganglia, and in the size, number, and direction of the convolutions. It is stated by Leuret,† that the cerebral convolutions of the Mammalia are alike in the same animal, and that the Mammalia may be classified by the similitude of their cerebral convolutions.

The classification which is founded upon these convolutions differs in many essential points from that which is based upon the form of their organs of prehension; it associates animals of corresponding faculties, and separates those which differ in this respect. The cerebral convolutions have many well-marked types, which may easily be traced one into the other.

No portion of the study of the brain is at first sight so unpromising, unsatisfactory and puzzling, as that of the convolutions; they appear so complicated, indefinite, confused, and countless, that few can be induced even to consider the subject. If, however, they will take the trouble to investigate it a little, they will be rewarded, by finding it much more simple than it at first sight appears.

In order to understand the various forms which the convoluted surface of the brain assumes in different animals, we will suppose the hemispheres to be a flat layer of soft material, such as a piece of putty; but as this is not always at hand for the purposes of illustration, take a piece of cloth, and a small lozenge-box. In the lowest animals the brain is smooth: to imitate this, the cloth may be cut the size of the box, and it will go in without folding, and be smooth like the brain of the rat or hedgehog. But a little higher in the scale of animals, as in the agouti, for instance, the surface is not quite smooth; there is one slight longitudinal furrow (fig. 63). We may now cut the cloth a little larger than the box, and one very slight fold is sufficient to get it in. A little higher in the animal scale, and we find two or three folds, but all still in the longitudinal direction; in the same way then to imitate these, the cloth must be cut still larger, and folded longitudinally. Still rising in the scale, the brain goes on increasing; we must now, therefore, as the additional size is given by additional length, make transverse as well as longitudinal folds. Suppose a surface to have been folded thus, like the upper figure, but which cannot be packed in the box because it is a





* Cuvier, Leçons, vol. iii. p. 99, 2d ed., 1845.

† Op. cit., vol. i. p. 451.

little too long for it; we then bend it a little in the opposite direction: the effect would thus be to produce a transverse furrow, as in the lower figure; and this, in fact, is the next step in the complication of the convolutions. At first, these folds are very short, and only connect the longitudinal folds together; but in the higher animals, elephants, apes, and man, they are so large that they divide the longitudinal convolutions.

We may now turn to the anatomical facts, and see if we can realize and digest them; and we do so the easier for the above most homely illustration; I trust it will be forgiven, even by those who, unlike the author, could have understood them without some such clue to their meaning.

These explanations will, I think, be easily understood as we proceed, by referring to the following figures, taken from Leuret. To assist in remembering the course of the convolutions, and their variety in different species, we may consider the longitudinal foldings as the result of pressure from above and below; the transverse foldings, from before and behind.

It is a curious coincidence, to say the least of it, that as the longest heads in the human species contain the most active and intellectual brains, so is the greatest advance from the lower form of brain to the higher made by lengthening the brain, as shown by the transverse foldings. It is an old saying, and a true one, in speaking of a clever man, "He is a long-headed fellow."

Professor Owen, in a paper communicated to the Zoological Society as far back as 1833, began a classification of the convolutions of the brain. His paper was simply entitled, "The Anatomy of the Cheetah, *Felis jubata*." He continued his observations to the feline and canine race. They are very clear, and point out the same longitudinal furrowing which was afterwards described by Leuret, as will be shown further on. I have thought it better to follow the latter, as his descriptions are more extended, and quite confirm the observation of Professor Owen, who observes, that the constancy manifested in the disposition of the convolutions, as to their form, extent, and symmetrical arrangement, argues strongly in favor of the conclusion that the folding of the hemispherical substance in the progress of development follows a determinate law.

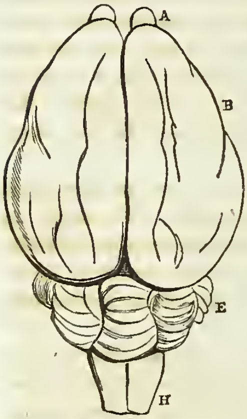
A classification of animals in relation to their convolutions, will be found to accord with the extent of their intelligence; animals may be divided into groups, in accordance with the form of their convolutions.

The *first group* includes animals taken from different families, viz., the Cheiroptera or Bats (fig. 62), the Insectivora (61), the Marsupiata (fig. 40), the Monotremata, and especially the Rodentia (41, 47). They correspond, as regards the absence of convolutions, to those birds which have but little intelligence.

In the second group there are still no convolutions, but there are depressions which announce, as it were, their approach. The animals which compose this group are from the Rodentia, the Insectivora, and the Marsupiata. Besides the fissura Sylvii, which is here more prominent than in the first group, there are depressions upon the cerebral lobe

which have a certain regularity, as may be seen in the examination of the brain of the hare and agouti.

Fig. 63.

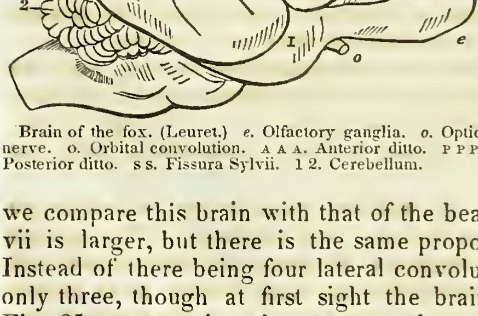


Upper surface of the brain of the agouti. (Leuret.) Slight tracing of the longitudinal convolutions. A. Olfactory ganglia. B. Hemispherical ganglia. E. Cerebellum. H. Spinal cord.

On each side of the median furrow, which extends from before to behind, we see a parallel furrow which circumscribes a portion of cerebral substance, having almost the aspect of a convolution: this is well seen in the agouti (fig. 63). In the beaver (see fig. 40) we see some furrows less prolonged but more deep, having the same direction as those in the hare and agouti. Gall and Spurzheim were in error when they stated that the number of convolutions is in relation to the volume of the brain; for instance, in the brain of the ferret there are five convolutions very distinct, three external, one internal, an anterior or supra-orbital; yet the brain is not equal to that of the squirrel, which is without convolutions or furrows, and it is much inferior to that of the hare, of the porcupine, of the paca, agouti, beaver, &c. These latter have a brain more voluminous than the ferret and the polecat. Nevertheless, it is generally true that those species of animals which have the most voluminous brains, have also the convolutions and undulations most numerous and varied.

M. Leuret illustrates his views regarding the cerebral convolutions by a demonstration of the convolutions of the brain of the fox (see fig. 64), exhibiting the external face of the right hemisphere of the brain: S, marks a deep furrow, passing obliquely upwards and backwards—the fissura Sylvii. There is a rounded body surrounding this fissure—this is the first convolution; a second, third, and fourth, are placed one above the other, making four convolutions; before these, placed in front, there is a fifth (O), the supra-orbital. The sixth, and last (I), forms at the under part of the middle lobe the hippocampal convolution. If we compare this brain with that of the bear, we find that the fissura Sylvii is larger, but there is the same proportion to the rest of the brain. Instead of there being four lateral convolutions, as in the fox, there are only three, though at first sight the brain appears more complicated. Fig. 65, representing the upper surface of the brain of the fox, shows

Fig. 64.

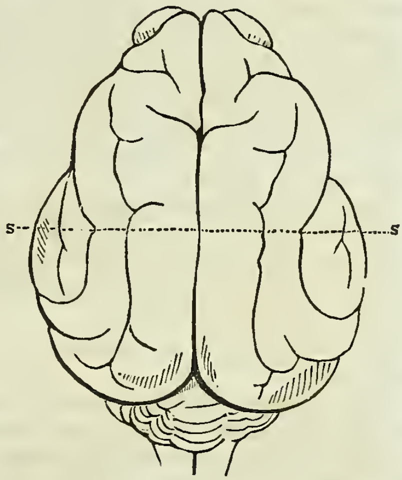


Brain of the fox. (Leuret.) *e*. Olfactory ganglia. *o*. Optic nerve. O. Orbital convolution. A A A. Anterior ditto. P P P. Posterior ditto. S S. Fissura Sylvii. 1 2. Cerebellum.

the completion of the fourth convolution, of which fig. 64 shows the internal and posterior part.

The third group contains the fox, wolf, &c. The convolutions of the brain of the wolf are the same in number as those of the fox, only there are more numerous depressions, and a very prolonged furrow upon the third external convolution, in the spot where in the fox there is only a rudiment of a depression. Leuret states that he has compared the brains of dogs of different species, and he has always found the same type, the same convolutions, without any difference but in the number of the depressions, and extent of the undulations; this difference corresponds to the volume of the brain.

Fig. 65.



Upper surface of the brain of the fox. (Leuret.) s s. Fissura Sylvii.

Fourth group.—All animals of the genus Cat and Hyena are comprised in this group. As in the preceding group, the smaller the brain, the fewer the convolutions and depressions. There are many essential differences with regard to the cerebral convolutions between the fox tribe, which includes the dogs, and wolves, and the cats. In these latter (fig. 60), we find four external longitudinal convolutions, one internal, and one supra-orbital. But, contrary to the arrangement in the brain of the foxes, these convolutions have many points of union, which, I believe, arises from the greater length of the ganglion requiring it to be pushed up together in its long axis: at the place marked s in fig. 60, there is a furrow, which represents the fissura Sylvii; this furrow is very much developed in the panther, in the lion, and all the large species of this genus.

Fifth group.—They are varied, but they have this common point of resemblance—that the number is only five, three external, one supra-orbital, and the fifth internal.

The civet forms a very natural and easy transition between the bears and the foxes. The genet forms a transition between the brain of the civet and that of the marten.

In the coati there are but three external convolutions; the first is of unequal size in different parts of its extent: behind the fissura Sylvii it is very much enlarged; above that fissure it recedes upon itself, and remains partly below the anterior portion of the second convolution. The same disposition is met with in the weazel, the marten, the otter, and the bear.

The second convolution is in an inverse ratio to the first, being larger before than behind.

The third convolution, simple and regular in the ferret, has in the polecat a fissure behind, which is replaced on the two sides. The coati has more depressions. Viewing the brain of the ferret, weazel, coati, badger, and polecat, above, a transverse fissure may be seen to cut the mesial fissure, like the letter V. The convolution in front of this fissure, which forms the anterior point of the brain, is a portion of the internal convolution, which, commencing at the hippocampal lobe, runs backwards, embraces the corpus callosum, and rising anteriorly to unite with the superior convolution. Above the orbit is the last convolution, the supra-orbital; it is furrowed for the olfactory commissure.

The brains of the fifth group form a sort of transition between the foxes and the sheep.

The sixth group includes only the ichneumons.

The seventh group includes the two-toed sloth, the ai or three-toed sloth, the African ant-eater, phascolomys or wombat, and the hyrax or coney. In none of the animals composing this group do we meet with a single transverse furrow.

The eighth group includes the pteropus, or fox-like bat, kangaroo, orycteropus.

Ninth group.—The brain of the genus Sheep, including the Ruminantia (figs. 49 and 50), which forms the ninth group, has in reality only four convolutions; one internal, one infra-orbital, two external, which have numerous divisions, some depressions, and a form very undulating. It is a sort of amplification of the brain of the orycteropus.

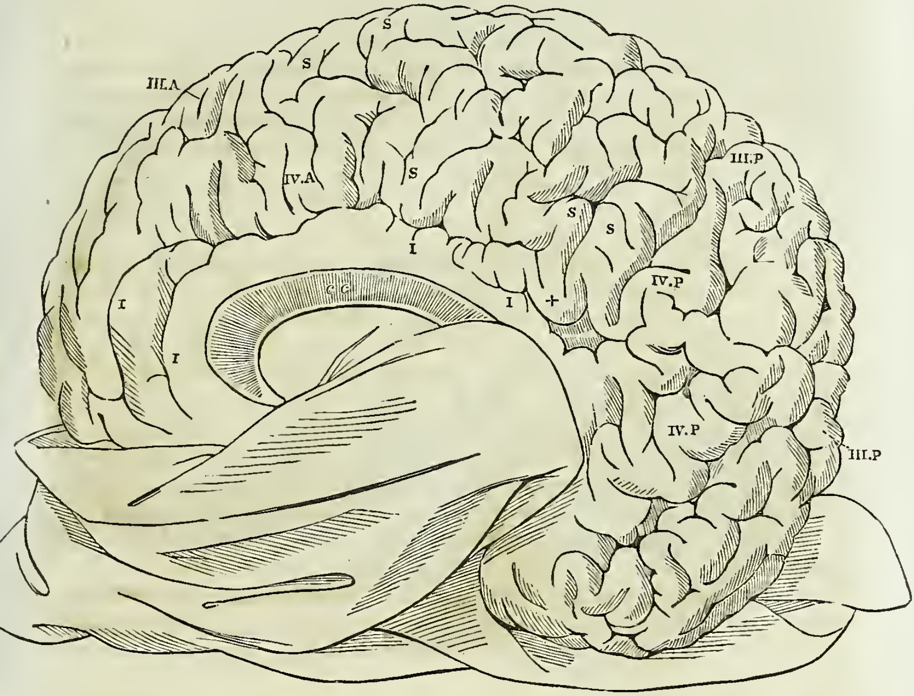
The convolutions of this group, in their general aspect, do not resemble those of the foxes, cats, or bears; they have more analogy to the convolutions in the human brain. Viewed above, we observe the longitudinal foldings much doubled up, so as to produce many transverse folds.

We cannot attempt to follow out all the minute varieties in the convolutions of the tenth, eleventh, and twelfth groups of M. Leuret, which includes the pigs, the seals, and the Cetacea, but proceed to the thirteenth group. With the exception of suborbital convolutions, the convolutions of the brain of animals below this group are all directed from before to behind—they traverse the brain longitudinally. Between these convolutions in many brains there are points of union, a sort of soldering or joint; they are found in the cat, bears, otter, sheep (fig. 49), &c.; but all are parallel, none are placed transversely to the brain, cutting the longitudinal convolutions into two parts, and dividing them into *anterior* and *posterior convolutions.* This division of the longitudinal convolutions, this addition of new convolutions, is found only in the elephant, the apes, and in man (see figs. 66 and 67, and the descriptions).

Fourteenth group.—In the apes, and especially the monkeys, the convolutions are not so undulating and voluminous as in the elephant and whale; thus they appear at first sight to be further from man than the latter: but a little attentive observation soon dispels this illusion. The general form of the brain of the monkey, its development behind, the extent and degree of inclination of the fissura Sylvii, form a brain as an embryonic perfectioning of the brain of man, whilst the brain of the ele-

phant, and especially that of the whale, considered in their different relations, descend towards the form of the brain of other Mammalia.

Fig. 66.



Internal surface of the right hemisphere of the Indian elephant. (Leuret.) C C. Corpus callosum. I I I I. Internal convolution. This convolution, above and behind the corpus callosum, sends a prolongation, +, which is united to the superior convolutions, s s s s. Leuret states that he has never met with this disposition of the convolutions, except in man, the ape, and in the elephant. This portion cuts the antero-posterior convolutions into two portions, of which some are anterior and the others posterior. III.P, III.P. Third posterior convolution. IV.P, IV.P. Fourth posterior convolution. III.A. Third anterior convolution. IV. Fourth anterior convolution. "Suppose," says Leuret, "that all the superior convolutions, s s s s, and the prolongation, +, of the internal convolution are obliterated, the fourth anterior convolution might be united to the fourth posterior convolution, the third to the third, and we should have one of the groups of convolutions of the brain of the Ruminants and Solipedes." Reduced one half.

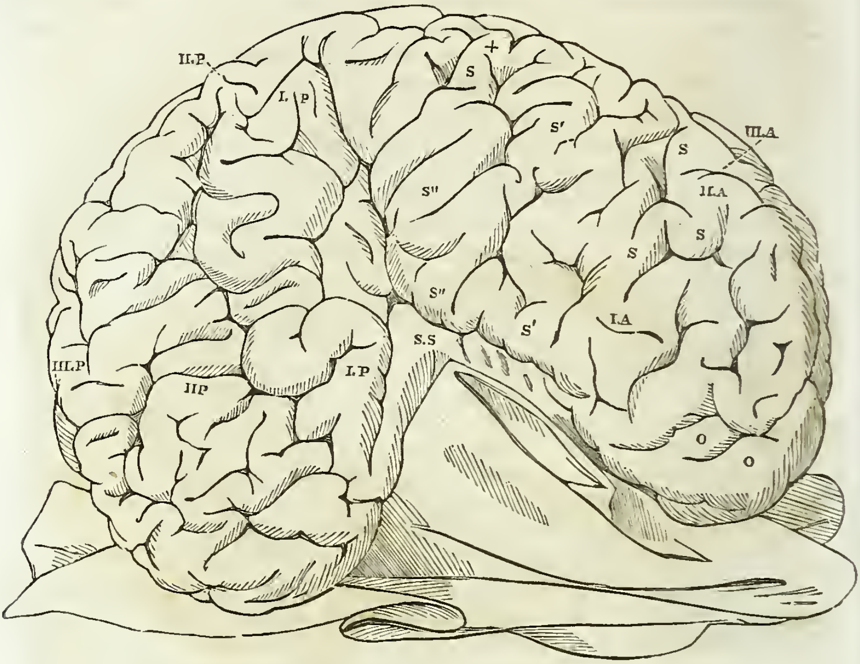
The ape has three anterior convolutions (I. A, II. A, III. A., fig. 68), three posterior (I. P, II. P, III. P, fig. 68), two superior (S S, S S), one internal, and the supra-orbital convolutions, also corresponding to those in man (figs. 73-4-5). The orbital convolutions always exist; they are larger and better divided than in the inferior animals, but they do not show the same regularity as the others.

"The brain of the chimpanzee," says Mr. Owen, "in the relative proportions of the different parts, and the disposition of the convolutions, especially those of the posterior lobes, approaches nearest to the human brain; it differs chiefly in the flatness of the hemispheres, in the comparative shortness of the posterior, and in the narrowness of the anterior lobes."

It also approaches nearer to the human brain than that of the other Mammalia, in the absence of the corpus trapezoidum (see College pre-

paration 1338), which, I observe, exists in the brain of many of the apes, though I cannot affirm that the chimpanzee is the only exception.

Fig. 67.



The cerebral surface of the right lobe of the brain of the Indian elephant. (Leuret.) s s. Fissura Sylvii. I.A, II.A, III.A. Three anterior convolutions. They all have a common origin from the convolutions s s s, which is the most anterior of the superior convolutions. Behind the superior convolutions s s s, there is a fissure, the analogue of which exists in man and the ape, and which Leuret calls the fissure of Rolando. Below this fissure are seen some voluminous superior convolutions, s′ s′ s′′ s′′, which, like the convolutions s s s, intercept the continuity of the anterior with the posterior convolutions. I.P, I.P. First posterior convolution situated behind the fissura Sylvii, and which is reunited to the convolution I.A. if the superior convolutions do not exist. II.P, II.P. Second posterior convolution. III.P. Third posterior convolution. O O. Supra-orbital convolution. Leuret states that he has taken great pains to have the size of the drawing accurate. The cut is reduced one-half.

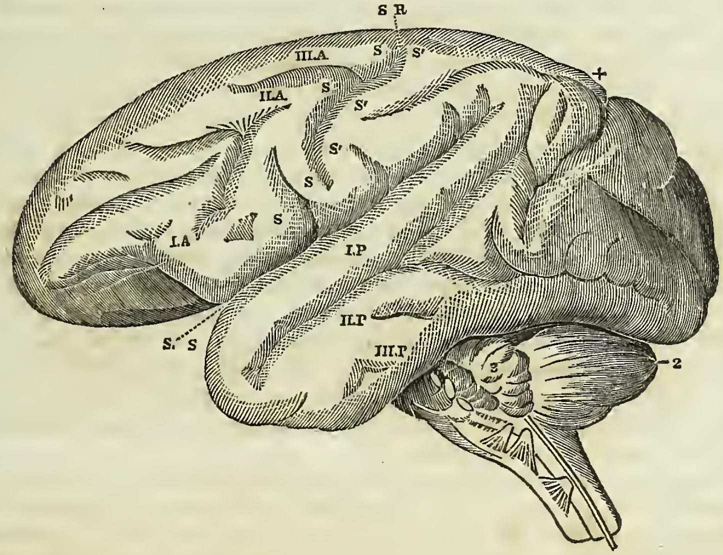
"The number, form, arrangement, and relations of the cerebral convolutions," says Leuret,* "are not formed at hazard: every family of animals has a brain formed in a determinate manner, and the difference of opinions on this subject arise from the want of attentive examination of a sufficient number of brains. Observation has thus shown what strict induction had led us to conclude. How, indeed, can we believe, that the most important organ of the economy, that by which the manifestations of intelligence operate, to which is attributed the instincts and passions, has not a fixed organization, and as invariable as that of other parts. Each group of brains has a type which is proper to it, and this type is especially manifested by the form of its convolutions."

"In the foxes the divisions are clear and well marked; in the cats

* Op. cit., p. 399.

the divisions are less, but still the forms are fixed and very simple; in the bears and martens there is a tendency to another form, complete preservation of some convolutions, which I have called primitive, on account of their simplicity, and disposition of some of the others to unite and present undulations. In the next type, the fundamental separations are less numerous and of greater variety in their details for the different groups to which the wombat, kangaroo, roebuck, pig, seal, and whale belong. Next, as in the elephant, an entire addition to the general forms, with an infinite development of details. In the ape a still more perfect type, nearer to man, but incomplete and rudimentary."

Fig. 68.



Left side of the brain of the baboon (*Singe Papio*). (Leuret.) S S. Fissure of Sylvius, running obliquely from before backwards. S R. Fissure of Rolando. S S S, S' S' S'. The two superior convolutions. I.A, II.A, III.A. First, second, and third anterior convolutions, arising all three from the same superior convolution. I.P, II.P, III.P. First, second, and third posterior convolutions. The first, long, isolated, and turned round above the fissura Sylvii, and directed towards the first anterior convolution, from which it is separated by the lowest part of the superior convolutions. The second and third convolutions are carried above and behind the cerebellum, and are in part confounded one with the other. + Point of reunion and prolongation of the superior convolution, S' S' S', with the prolongation of the internal convolution. 2. Lateral lobe of the cerebellum. 3. Third lobe of the cerebellum, or *flocons*.

"In each family, as a general rule, the more the brain increases, the more it divides, the more also it acquires undulations. The fox, the domestic cat, the weazel, the ferret, the roebuck, the peccary, each represents the first step of a scale, at the summit of which is the dog, the lion, the otter, the hyrax, and the boar. In its class the elephant is at the summit; but I know of no animal which can be placed at the opposite end. In its own class the lemur is very low, the ape very high, and man very far above the ape. However, there are some large brains which do not represent a perfect type of some small brains of the same class. Thus, that of the ox is not more perfect than that of the sheep, that of the whale is not above that of the porpoise." "Are there inter-

mediate degrees," modestly says Leuret, "between all these brains? Are there any forms of brain different from those that I have described? Observations more extended can alone resolve these questions, which are of the deepest interest for anatomy and psychology."

Cerebral Vessels.—In the Mammalia, below the human subject, the brain is not supplied by the same set of blood-vessels. In man, we find the two internal carotid and two vertebral arteries, distributing their branches almost entirely to the brain; but it is by no means invariably the case throughout the class of mammals. Without pretending to give a minute account of these varieties, I shall briefly refer to some of the most interesting.

When we have advanced to the study of the cerebral vessels in man, we shall meet with a beautiful contrivance to avert the force of the heart's action on the brain. The carotid and vertebral arteries, instead of running directly in a straight line from the heart into the skull, are bent twice nearly at a right angle, thus twice changing a perpendicular to an horizontal course. In some of the lower animals—the cat, for instance—the vertebral artery is turned as in man. But, in addition to this arrangement of these vessels, we meet with another of great physiological interest, and evidently intended to serve the same purpose. This is formed by the division of the carotid artery within the skull into numberless small vessels, which, meeting again, form a most wonderful net-work—*rete mirabile*—and well has it been thus named. It was first discovered and described by Galen. A trunk is formed by the union of these vessels, which supplies the brain. We shall have occasion to consider the formation of this rete again, when we have turned our attention to some of the peculiarities regarding the relative size and distribution of the carotid and vertebral arteries. The carotid arteries are subject also to much variety.

Sometimes the common carotid arteries bifurcate, as in man, into external and internal carotids, the latter maintaining a large calibre. Sometimes, as in some of the baboons, the common carotid, after having given off the usual branches of the external carotid, enters the cranium as the internal, which in other instances appears like a subordinate branch of the external carotid. In the common porpoise, the large size of whose brain we have already observed, the carotid divides nearly as in man, with merely the exception that it gives off the superior thyroid and a cervical branch first.

In the tiger, the internal carotid is not given off until the common carotid has distributed the usual branches of the external.*

The internal carotid does not give off the ophthalmic artery in the Carnivora, Rodentia, Ruminantia, or Pachydermata. This vessel ascends into the orbit through the foramen lacerum orbitare inferius, which is very large.

In those ruminants in whom the rete mirabile exists, a true internal carotid can scarcely be said to be present, but its place is supplied by two vessels on each side, one of which enters the skull by a foramen which corresponds to the foramen rotundum and foramen orbitare supe-

* Cuvier, Leçons, ed. 1839, t. vi.

rius, the other through the foramen ovale. In the pig, the largest of the two vessels passes through the foramen lacerum basis cranii, and a smaller one through an interior portion of the same foramen. The carotid canal is absent in all cases where the plexus is present; but its absence does not necessarily indicate the presence of a plexus.

The vertebral artery is subject to much variety both in regard to its origin, distribution and size; in some animals, as the hedgehog, it arises from the common carotid.

In this animal, and in the hybernating Rodentia, it is much larger than the carotid; also in some other of the Rodentia, as the rabbit. In these cases, the basilar artery forms nearly the whole of the circle of Willis, furnishing the anterior as well as the posterior arteries of the brain.* This fact is important in reference to experiments made with ligatures on the internal carotids, and the deductions from them in relation to the physiology of the brain.

Professor Rapp, of Tubingen,† states, that "the vertebral arteries do not reach the brain in all those animals that possess a rete mirabile." In Ruminants, the vertebral arteries usually enter the spinal canal, between the second and third cervical vertebræ, without piercing the dura mater of the cord: they then join, but separate again almost immediately: in the calf and goat, these arteries are connected by transverse branches; this union seems to indicate a basilar artery, although it does not take place in the skull, nor internal to the dura mater. Each artery, after having given off twigs to the various muscles, joins on the atlas the condyloid artery, a branch of the external carotid, which comes through the condyloid foramen into the skull; then, without piercing the dura mater, turns backwards, receives the vertebral arteries, then passes through a foramen in the atlas, anastomoses with a branch of the external carotid, and is distributed to the muscles at the back of the neck. This union of the vertebral arteries, with a twig of the external carotid, is remarkable, and explains why, in an animal in whom no blood is carried to the brain by the vertebral arteries, both common carotids may be tied without causing the death of the animal. This operation has been performed by Parry on sheep."

In the stags and chamois there is a considerable anastomosis between the rete mirabile, the condyloid artery, and a vessel in which the anterior spinal artery terminates; the anastomosing branch passing through the jugular foramen into the skull.

In the calf, also, there is an anastomosis between branches of the vertebral artery and rete mirabile (see fig. 69, E).

The rete mirabile may be exposed in the skull of the sheep and calf, which are convenient for the purpose, by raising the dura mater on each side of the sella turcica, and then opening the cavernous sinus. If the vessels are filled with red wax, they present the beautiful appearance represented in fig. 69. This plexus is surrounded by the venous blood of the sinus, the sixth pair of nerves running through it. The vessels of the rete anastomose freely: in the swine, beneath the pituitary gland; posterior to it in the goat, stag, sheep, and roe.

* Cuvier, ed. 1839, vol. vi. p. 118.

† Meckel's Archives for 1827, p. 5.

This rete mirabile has a different appearance in different animals, so that when separated from the skull it cannot be recognized as coming from any particular animal. In the *calf* the vessels forming the plexus are comparatively thick, and make numerous abrupt curves. In the goat and chamois they are in this respect most like the calf; in all these the net is very close. In the stag it is more open. In the sheep the vessels are thin, and very numerous and straight. We have a good preparation of it, from this animal, in the Museum of St. Thomas's Hospital, made by Sir Astley Cooper. In the fœtus it is comparatively larger than in the full-grown animal, corresponding with the size of the brain.

Fig. 69.

Rete mirabile of the calf. (Rapp.) The cavity of the skull and the spinal canal are opened; the brain, spinal cord, and dura mater have been removed. A. The cerebral carotid arteries arising from the rete mirabile. B. The vertebral arteries in the spinal canal. C C. The vertebral arteries passing through the foramen in the atlas. D. Branches of the vertebral arteries passing forwards under the dura mater to anastomose with the arteria condyloidea, forming thus a plexus which is connected to the rete mirabile. E. Arteria condyloidea.

Professor Rapp found the vessels slightly atrophied in cases of partial destruction of the brain by the cœnurus cerebralis. The cerebral carotid is formed by a union of all the twigs of this plexus. The artery always penetrates the dura mater on the side of the pituitary gland, and then forms the circle of Willis, and gives off branches perfectly similar to those in man. From the posterior portion of the circle arises a vessel, which has erroneously been called the basilary, but is really the anterior artery of the spinal cord.

Rapp found this plexus in the stag, roe, the fallow-deer, chamois, the goat, sheep, and calf, and oxen. He considers that the arrangement of the foramina in the base of the skull in the camel indicates its existence in this animal, but he has not had the opportunity of seeing the parts in a recent state. It exists also in swine, but it does not occur in other Mammalia besides the Ruminantia and swine. Cuvier's statement certainly differs from this: he says that this vascular arrangement appears to occur in most of the Carnivora, but is absent in the elephant and beaver. According to Carus it is present in most Mammalia, and Willis says it exists in the dog, the fox, cat, &c.; but this is a mistake, for it does *not* occur in the dog, fox, badger, weazel, otter, or hedgehog, or in the domestic cat. But it has been found by Mr. Quekett in the leopard. Neither is it found in man, the apes, horse, elephant, or the Rodentia. In the domestic cat there is an arterial plexus beneath the orbit, anterior to the articulation of the lower jaw, which sends anastomoses through the supra-orbitar fissure to the carotis cerebralis in the cranium, which is thus enlarged immediately after entering the skull at the anterior and internal extremity of the petrous bone. Rapp found a similar rete mirabile of the ophthalmic in all Ruminants, but not in swine; this ophthalmic rete mirabile is formed out of the arteria ophthalmica, a branch of the external carotid: it lies between the musculus suspensorius and the rectus superior; out of this net arise the ciliary arteries; it is peculiarly beautiful in the sheep, and smaller in the goat. In the horse the carotids do not enter through a carotid canal, but through a foramen lacerum, and are then united by a thick transverse branch before penetrating the dura mater.

Harwood suggested that the office of this plexus was to moderate the pressure of the blood against the brain in those animals in whom the position of the head was constantly depending. But Rapp does not agree with him, though he allows that it will moderate pressure; but that it has no relation to position.

In the horse this result is obtained by the strong bendings of the cerebral carotid and by the vertebral arteries which also supply the brain.

It was supposed to be absent in the giraffe, and this, in connection with the mode in which this animal obtains its food from the branches of trees, instead of stooping to crop it from the ground, was considered an additional argument in favor of Harwood's opinion. Mr. Quekett, of the College of Surgeons, has, however, succeeded in injecting and clearly demonstrating its existence.

PART III.

PROTECTIVE APPARATUS OF THE HUMAN BRAIN.

From what has been already said regarding the important office of the cerebro-spinal axis, our reader will be prepared to find in man some special and beautiful provision for its protection.

The materials which form the protective apparatus may be classed under three heads: 1. The osseous or bony. 2. The membranous. 3. The aqueous or fluid. The bony apparatus of protection in the lower animals, as, for instance, in many insects, in the lobster and crab tribes, &c., is formed by a simple hardening of the general covering or integument of the body; and the skeleton which is thus formed is called a dermal or skin skeleton. The inconvenience of such an arrangement must be evident, when we consider that this skeleton must be cast off periodically in order to allow the animal to increase in size. The lobster throws off its shell, and draws its limbs out of their calcareous coverings, as we do our legs out of our boots. But during the period while the new skeleton is growing, the animal is left in a miserably weak and helpless condition, an easy prey to its enemies.

In the higher animals the skeleton is as much a part of the living creature as the soft skin, muscles, or other living tissues, and is placed within the body, increasing as the organs which it protects increase in size.

The osseous framework which in man appears so complicated, and performs, with its connecting ligaments and attendant muscles, so many and such various offices, as prehension, mastication, locomotion, &c., in the simple form in which it first appears in the animal kingdom, is first a tube of cartilage, or a jointed column inclosing the spinal cord, without appendages or limbs for other functions. This is called the vertebral column. Its presence in the animal kingdom is so clear a mark of a comparatively high development of the nervous system, that physiologists, as we have already seen, divide animals into two great groups, the Invertebrata, or creatures without vertebræ; and the Vertebrata, or animals possessing a vertebral column. It would not be consistent with the plan of this work to enter into a description of the mechanism of the vertebral column in the different classes of animals. If we once entered on this subject, the abundance of matter, and the interest attaching to it, would render it very difficult to us to abandon it. We shall, therefore, merely remark that the cerebro-spinal axis in man is situated in a long bony canal, which is expanded superiorly into a cavity of considerable size. The difference in the dimensions of the two portions of this canal

has led anatomists to divide it in their descriptions, the upper portion being called the skull or cranium, the lower the vertebral or spinal canal. Now, though in man this division seems even natural, the two portions differing so entirely in size and general appearance, still if we observe the same parts in the lower orders of animals, and trace their alterations of form, and capacity as the organs which they contain increase in size, and require a change in the shape and extent of the cavity which contains them, we shall find that the bones composing the human skull are simply vertebræ in a more expanded form, and exhibit those alterations in shape which adapt them to the increased size of the organ they are formed to protect.*

The student, in considering the relation of this osseous envelop to the brain, must bear in mind its vital properties—that the skull, which so beautifully protects this delicate organ by its physical hardness, is modeled in its form and shape by a soft substance like the brain. The facts which have been accumulated of late years, showing that the form of the skull alters at different periods of life, are extremely interesting and important. As illustrating the physiology of the brain, they will be referred to hereafter. If the brain were not protected by an internal skeleton, this, of course, could not take place; and, even in the present day, it is not uncommon to hear the opponents of phrenology ridicule the idea of the soft brain producing any impression on the hard skull.

As the following description of the anatomy of the cerebro-spinal mass in the human being is intended to assist those who are commencing their studies, the best mode of opening the skull and vertebral canal so as to reach without injury, and to expose the structure of, the nervous masses contained within them, shall next be explained.

The student should place the subject on its face, and, raising the head, rest the chin upon a block, so as to fix it in a horizontal position.

An incision must then be made through the scalp, extending across the vertex from ear to ear. The anterior part of the scalp may then be forcibly torn, instead of being dissected, from the skull over the face, and the posterior over the occiput, which will save much time; but some force is required to effect this reflection of the integuments.

A deep groove must be made with the saw through the outer table and diploë, commencing half an inch above the superciliary ridges an-

* This opinion, that the cranium is formed by a series of vertebræ, originated with Peter Frank (see Edinb. Med. Surgical Journal, vol. xliii. p. 288), (Epit. de Curand. Hom. Morb., lib. ii. p. 42), and Burdin (Cours d'Etudes Médicales, Paris, 1803, tome i. p. 16); and was afterwards espoused by Kielmeyer (Ulrich, Annotationes quædam de Sensu ac Significatione Ossium Capitis, Berlin, 1816, p. 4), Dumeril (Magazine Encyclopédique, tome iii. 1808), and Goethe (Zur Naturwissenschaft, Band i. p. 250), and more or less fully illustrated by Oken (Ueber die Bedeutung der Schädelknocken, Jena, 1807; Isis, 1820, No. VI. p. 552), Spix (Cephalogenesis, Munich, 1815). De Blainville (Bulletin de la Soc. Philom., 1816, p. 111, and 1817), Geoffroy St. Hilaire (Philosophie Anatomique, Paris, 1818–22), Carus (Lehrbuch der Zootomie, Leipzig, 1818, p. 164), Meckel (Beyträge zur Vergleichenden Anatomie, Band ii. Stück ii.), Schultz (De Primordiis Systematis Ossium, &c., Halle, 1818, p. 13), Bojanus (Isis, 1818, p. 301; 1819, p. 1364), and Burdach (Vierter Bericht von der Anatomischen Anstalt zu Koenigsberg, Leipzig, 1821). Arnold also adopts this principle, but confines himself to the views given by Oken, Cuvier, Carus, Spix, and Meckel, considering that the cranium consists of three vertebræ only; not, therefore, agreeing with Geoffroy St. Hilaire, who believes that he can there demonstrate the parts of nine vertebræ.

teriorly, and extending round the entire skull to the protuberance of the os occipitis posteriorly.

A small axe should next be used to break the inner table, which is much better than sawing it entirely through, as being less likely to injure the dura mater and brain, and as permitting the skull to be more firmly fixed again when replaced after the dissection is completed.

The skull-cap being removed, a dense fibrous membrane is perceived beneath it, rough on its surface owing to the torn extremities of the vessels which connected it to the internal table of the skull; for this membrane, which is the internal periosteum of the cranial bones, and in the young subject connected at the edges of the several bones with the external periosteum, adheres to the bones so closely that they are with difficulty separated. The glistening membrane thus exposed is called the *dura mater*, from the density and firmness of its texture, and from an idea that it was the origin or mother of all the other fibrous membranes of the body.*

On the surface of this membrane are some small rounded bodies, which certainly were undeserving of notice if they had not received the grand title of *glandulæ Pacchioni*.† These are scarcely observable in the young subject, and in the old are most probably a morbid appearance. The dura mater should next be cut through carefully all round with a pair of scissors, on a level with the divided edge of the skull. On being turned back over the upper part of the brain, we discover that its under surface is smooth and polished; a circumstance which does not arise from any peculiarity in the texture of its internal surface as opposed to the external, but from the presence of a serous membrane, called the *tunica arachnoidea*, which, like all serous membranes, is a thin diaphanous web, covering the contained viscus, and reflected from thence on to the internal surface of the walls of the containing cavity. The next membrane, therefore, which we observe covering the brain when the dura mater is raised, is that portion of the arachnoid‡ which, from its investing the brain, may be called the *tunica arachnoidea cerebralis* or *investiens*, in contradistinction to that portion which lines the

* Portal iv. 2. The membranes of the brain, by the Greeks, were called meninges, the Greek word μήνιγξ simply signifying a membrane. The term *mater*, or mother, originated with the Arabs, and the credit of having shown that the dura mater does not accompany the nerves in their passage from the skull, and that the membranes in general are therefore not continuous with it, is due to Ludwig.

† So called after Pacchionus, who first described them as glandular structures destined to secrete a peculiar lymph: he even went so far as to state that their secretory ducts terminate in the longitudinal sinus. Cruveilhier (Anat. Descript., tome iv.) acknowledges our ignorance of their nature, but scarcely regards them as a morbid production: their seat is in the subarachnoid cellular tissue.

Wengel, (De penitiori structura cerebri hominis et brutorum,) p. 17, 1812, says, after detailing the opinion of Malacarne in support of that of Pacchionus, "Eorum ortus absque dubio a morboso statu, inconstans incertus, ex octate aliisque fortuito accidentibus circumstantiis est." En. Anat., vol. iii. 345.

Dr. Todd considers them as morbid products. "That they are," says this writer, "the product of a chronic, very gradual irritation, due to more or less frequent functional excitement of the brain itself."—"They are peculiar to the human subject. Nothing similar to them has been found in any of the inferior classes of animals."

‡ Portal, iv. 2. The arachnoid derives its name from its extreme delicacy and its resemblance to a cobweb; it was first described as a special membrane in 1565, by the Dutch Society, among the members of which was Swammerdam, the celebrated naturalist.

dura mater and is called the *tunica arachnoidea reflexa.* The further description of this membrane will be postponed until we have completed that of the dura mater. The dura mater forms several processes in the interior of the skull, some of which are best seen after the removal of the brain as directed further on, but which it will be in order to describe at once.

The dura mater consists of two layers united by cellular tissue, the external of which forms, as described, the internal periosteum of the bones of the skull. The separation between these two portions is perfect in the vertebral canal, though at the internal surface of the atlas, the spinal dura mater and periosteum of the vertebral canal meet together, and adhere so as to exhibit in the skull the appearance of one membrane. Dr. Knox, in the *Lancet* of the 19th October, 1839, remarks, that in some animals the vascularity of the external layer is very striking, as in certain Cetacea—the Rorqual, for example—where there is a perfectly distinct vascular layer between the dura mater, properly so called, and the Calvarium. This is not surprising, when we consider the vast thickness of the bones of the skull in these creatures.

Processes of the Dura Mater.—The internal layer is inflected downwards between the two symmetrical halves of the brain, forming what has been called, from its sickle-like appearance, the *falx major* of the dura mater (F M, figs. 70 and 71). This structure may be said to commence from the crista galli of the ethmoid bone, where it is, generally, about half an inch in width, though it varies in different subjects; from this point it extends backwards, gradually becoming wider in its passage, and being connected through the medium of the periosteal portion to the frontal, parietal, and occipital bones. On reaching the transverse ridge of the occipital it splits into two lateral portions, which are attached posteriorly and laterally to the transverse ridge of the occipital bone, while anteriorly it is attached to the superior angles of the petrous portions of the temporal bone, from which points it stretches itself up to the posterior clinoid processes of the sphenoid, leaving a space between its under surface, and that portion which covers the superior angles of the temporal bone, through which passes the fifth pair of nerves.

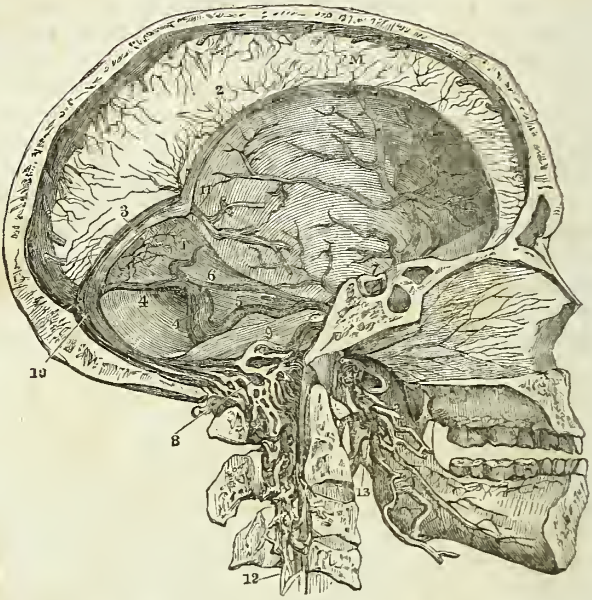
This portion of the dura mater is called the *tentorium* (T, fig. 70), and forms an extended surface on which the posterior lobes of the hemispheres rest; and by which the cerebellum, which is situated beneath, is protected from the superincumbent pressure of the brain (fig. 71): consequently, the tentorium so far resembles in its office the falx major, which prevents one hemisphere from pressing on the other when the head is inclined to either side.

Extending down along the mesial line of the occipital bone beneath the tentorium, there is another process analogous to, but much smaller than, the falx major; it separates the two lobes of the cerebellum, and has received the name of the *falx minor;* it commences on the internal surface of the occipital bone, at the point where the transverse and longitudinal ridges meet, and extends to the edge of the foramen magnum.

The veins, which return the blood from the substance of the brain, are protected from the pressure of that organ, by the stretching of the

dura mater over deep grooves in the bone, and by the mechanism of the falciform processes and tentorium of the dura mater, through the internal lamina of which they pass immediately after quitting the pia mater; the spaces formed for their reception by this peculiar arrangement of the dura mater are called *sinuses*, and require the attention of the student. There are fifteen sinuses in all.

Fig. 70.



Vertical section of the human head, and cervical portion of the spinal column. (Breschet.) This drawing shows almost all the various sinuses of the brain, the falx major, and the tentorium of the dura mater. 1. Superior longitudinal sinus. 2. Inferior ditto. 3. Straight sinus. 4. Lateral ditto. 5. Inferior petrosal sinus. 6. Superior ditto. 7. Circular sinus. 8. Venous plexus at the commencement of the spinal canal upon the anterior surface of the posterior arch of the atlas. This plexus communicates externally with the external vertebral veins, and with the venous plexuses which these vessels form on the transverse processes, and below with the large spinal veins or anterior longitudinal vertebral sinuses; before with the transverse sinuses on the basilary process of the occipital bone; posteriorly with the posterior occipital sinuses; lastly, they terminate in the lateral sinuses, close to the jugular foramen. 9. Communication of this plexus with the jugular vein through the anterior condyloid foramen. 10. Torcular Herophili. 11. Vena magna Galeni. 12. Anterior longitudinal sinus of the vertebral canal. 13. Pterygoid venous plexus. F M. Falx major. T. Tentorium.

The *superior longitudinal* (1, fig. 70), which is the largest, commences at the foramen cæcum of the frontal bone, and, passing back along the upper edge of the falx major, reaches the transverse ridge of the os occipitis, where it usually enters the right lateral sinus. Its shape is triangular, and the openings of the veins, which enter contrary to the course of the blood within it, may be distinctly seen on the interior. Surrounding these openings are small fibrous cords (the *cordæ Willisii*), adapted to keep the openings permanently free for the regular passage of the venous blood, any obstruction to the normal circulation of which endangers the life of the individual, by producing congestion of the brain. Running parallel with the superior longitudinal sinus, but along the inferior edge of the falx, we find a much smaller sinus, called the

inferior longitudinal (2, fig. 70). This also terminates generally in the left *lateral* sinus (4, fig. 70); previously, however, to its reaching this sinus, and when it is passing between the two layers of the tentorium, it receives the name of the *straight* sinus (3, fig. 70).

The course and extent of the *lateral* sinuses are distinctly marked in the dry skull; for they groove the transverse ridge of the occipital bone, and then crossing the posterior inferior angle of the parietal, reach the internal surface of the mastoid portion of the temporal bones, in which they are deeply imbedded, and thus effectually protected from the pressure of the cerebellum; they again cross a small portion of the occipital bone, and finally terminate at the foramina jugularia, beyond which they form the internal jugular veins: these sinuses have frequently another outlet for their contents, by means of the foramen mastoideum, and the vein which commences at this opening usually joins some of the deep-seated veins of the neck.

On each side of the sella turcica a considerable space is left between the dura mater and the bone, called the *cavernous* sinus; this cavity is not, however, constructed solely for the protection of the venous circulation. It contains the carotid artery, and guards, from the pressure of the brain, some of the cerebral nerves, in their passage to the orbit. The nerves, which are thus protected, are the third, fourth, first division of the fifth, and the sixth pairs.

The blood of the cavernous sinus, separated from the nerves by the lining membrane which is common to the whole venous system, flows into a sinus, called the *inferior petrosal* (5, fig. 70), a name derived from its proximity to the petrous portion of the temporal bone. The inferior petrosal sinus takes its course along the edge of the basilary process of the os occipitis, and terminates in the internal jugular vein. This sinus is connected with its fellow by a short sinus, the *transverse*. The *superior petrosal sinus* (6, fig. 70) deeply grooves the posterior edge of the superior angle of the temporal bone, and terminates in the lateral sinus.

Surrounding the pituitary gland in the sella turcica there is a circular sinus communicating with the cavernous sinus, called the *circular sinus of Ridley* (7, fig. 70).

The *occipital* sinuses, the last we have to mention, are situated on each side of the foramen magnum, and terminate at the point where the straight sinus and lateral sinus become conjoined; the triangular space left just before their junction is called the *torcular Herophili* (10, fig. 70).

Arteries.—These are derived from numerous sources; anteriorly there is a small branch from the ethmoidal, and another larger branch from the ophthalmic, just as it enters the orbit. In the centre of the skull there are also two branches, the smallest coming through the foramen lacerum medium, and derived from the ascending pharyngeal artery. The larger branch, which is the principal artery of the dura mater, called the middle meningeal, is given off by the internal maxillary, and penetrates the skull at the foramen spinosum of the sphenoid bone: this winds through a deep groove in the sphenoid and parietal bones up to the top of the skull. The posterior division derives its supply from the vertebral occipital and posterior aural arteries.

Nerves of the Dura Mater.—Cruveilhier (tome iv. p. 539), Haller,

Wrisberg, and Lobstein, denied the existence of any nerves to the dura mater, while Vieussens, Winslow, Lieutaud, Portal, Valsalva, and others, say that they observed some, but without giving a very satisfactory description. Cruveilhier states he recognized on each side of the mesial line two nervous filaments, extending from the fifth pair up to the vicinity of the superior longitudinal sinus; a third nervous filament occupying the thickness of the tentorium cerebelli, but whose origin could not be demonstrated.

Arnold has also described and delineated, and Pappenhein (Valentin, Repertorium, vol. v. p. 87) states, that this membrane is supplied by branches from the fourth pair, the frontal branch of the ophthalmic, the superior maxillary division of the fifth, and the Vidian.

The arachnoid membrane lines the dura mater, and covers the convoluted surface of the brain without dipping between the convolutions. It also covers the figurate surface* at the point where these two portions are continuous, as at the foramen of Bichat, as it is called, after the justly-celebrated man who first described it. The situation of this opening is between the anterior and superior portion of the cerebellum, and the under and posterior part of the cerebrum, as will be better understood when these parts have been described and the relations of the arachnoid explained.

F. Arnold, in a paper translated by R. Knox, with commentaries, *loc. cit.*, after quoting various opinions on this subject, says—"I entirely assent to the accuracy of Bichat's description, and think that the arachnoid proceeds to join the epithelium of the ventricles, as the amnion is in distinct continuation with the epidermis of the fœtus. In the dog, sheep, pig, calf, I have always found the foramen of Bichat to be a rounded opening, as described by him, and in which lies the vena magna of Galen. Burdach's idea is readily refuted by an appeal to the universal arrangement of serous membranes. But I cannot venture to affirm with Bichat that the investing membrane of the ventricles is a serous membrane. It seems to hold the same relation to the substance of the brain as the epidermis does to the corium; the serous membrane, or arachnoid, merely unites with the epithelium of the ventricles. This union of different membranes happens in woman, in respect to the peritoneum, and in birds and fishes. The nature of the ventricular epithelium is ever opposed to that of serous membranes, as being perforated by numerous blood-vessels." And Dr. Knox, *eodem locô*, says:—"The connection of the cerebral arachnoid with the great cerebral fissure of Vicq d'Azyr and Bichat, may be described in this way:—Commencing with the base of the brain, where the fissure commences, and tracing it upwards towards the upper surface, the arachnoid will be found to pass directly over the fissure, without in the slightest degree dipping into it; and this is a fact just as evident, and as easily made out, as that other fact, viz., that the arachnoid does not descend between the cerebral convolutions. But on tracing it quite up to the part of the fissure which is situated between the corpora quadrigemina and back part of the fornix and corpus callosum united, it is evident that the arachnoid does form

* The difference between the two surfaces of the brain will be thoroughly explained hereafter.

a short canal, precisely in the situation of, and around, the vena magna Galeni. How far this canal penetrates it is somewhat difficult to determine; in some of the brains I have examined, it scarcely proceeded an inch, in others less; but, however this may be, it is, I think, unquestionable that Bichat committed a great error in supposing that this canal proceeded into the interior of the ventricles, and that thus a passage was established between the ventricular cavities and the general serous cavity of the arachnoid. If we now return again to the commencement of the fissure at the base of the brain, and raise up the arachnoid from off the pia mater, which here, as elsewhere, lies directly beneath it, it will be found, I think, that the arrangement of this membrane (the pia mater) is very similar, in respect to the fissure, as with the common cerebral convolutions and anfractuosities. For first, a portion of it passes directly across the fissure; secondly, a process is sent inwards, to form the choroid plexuses and velum interpositum; and, thirdly, at the edges of the fissure the pia mater, besides adhering very closely at the edge, transmits a perfectly transparent and extremely delicate layer, filamentous and cellular, but not vascular, which, investing the opposing surfaces of the ventricular walls, constitutes the *proper ventricular membrane;* in short, the processes of the pia mater, which dip in between the convolutions, might almost be considered as analogous to the choroid plexuses, so similar are they in their arrangement, and perhaps, also, in their functions. A similar analogy subsists between the ventricular lining membrane, and that investing the opposing surfaces of the convolutions."

With this account by Dr. Knox I perfectly agree.

Cruveilhier* denies the continuity of the arachnoid membrane with the ventricular membrane, and the existence of the foramen of Bichat.

Burdach† describes the arachnoid as not entering into the ventricles; that the epithelium which covers them is too delicate to be continuous with it, and that which appears to be so, is rather to be considered as a sheath (Gefasscheide) derived from it.‡

The reflected or parietal portion of the arachnoid is closely attached to the dura mater, but the tissue cellulo-vasculaire or sub-arachnoid is interposed between the visceral or investing portion, and the pia mater of the spinal cord. The two internal surfaces of the arachnoid are closely in contact, and the bag which is between them is generally empty. But not so the sub-arachnoideal cavity, for this contains the important cerebro-spinal fluid. The cerebral portion of the arachnoid adheres very intimately to the pia mater at certain points, leaving in the intervals a considerable space for the accumulation of the liquid. It sinks into the great longitudinal fissure of the brain, lining the surfaces which bound it on either side, and passing across from right to left beneath the inferior margin of the falx, and above the great transverse commissure. In the same way, at the base of the brain, it passes over the fissura Sylvii, and diamond-shaped space.

Beneath the arachnoid is situated the pia mater, a membrane which

* Op. cit., t. iv. p. 700. † Page 24, vol. ii. op. cit.

‡ Mr. Rainey has demonstrated the existence of a very abundant supply of branches from the sympathetic nerve to the arachnoid; his paper is well worthy of perusal: Med.-Chir. Trans, vol. xxix. p. 85.

is constructed solely for the purpose of supporting the vessels distributed to the superficies of the central masses of the nervous system, which are so numerous that they require an especial tissue for their support. This structure dips between the convolutions of the brain, at the same time closely investing its external surface; it passes also over those surfaces which, from the old method of slicing the brain from above downwards, appear as if they formed the walls of cavities in the interior, and in some of these situations it has received peculiar names; among the most remarkable of its portions thus indicated, we may mention the plexus choroides in the lateral ventricles. Dr. Todd* informs us "that very numerous and tortuous blood-vessels are contained in these processes, forming a plexus which has given name to the folds themselves. The surface of each choroid plexus presents many slight projections or folds, resembling villi, in which are contained loops and plexiform anastomoses of minute vessels, very similar to the arrangement of the vessels of the villous processes of the chorion of the ovum, or those of the tufts of the placenta. These vessels are surrounded by an epithelium which has much the appearance of that of serous membranes. From the great number of these vessels, and from the delicate nature of the epithelial covering which surrounds them, it is plain that the choroid plexuses are well suited, either for the purpose of pouring out fluid, or of absorbing it. The epithelium may be best seen by examining the edge of a fold. It becomes very distinct when acted upon by acetic acid. As its particles are very delicate, and consist only of a single layer, they are easily detached. The cells of the epithelium are most of them six-sided, and contain a clear nucleus, or several minute granules. Valentin states that cilia may be seen playing upon this surface, especially in the embryo. I have observed the peculiar punctiform or spiniform formations to which he alludes, which look like the remains of former vibratile cilia."

Otto, in his Compendium of Pathological Anatomy,† states in general, that these two membranes, the arachnoid and pia mater, are inseparably united in the greatest part of the circumference of the brain in adults, and that they are at all times in organic connection throughout by means of fibro-mucous tissue of various length.

It will be instructive to dwell for a few moments upon the admirable adaptation of these three cerebral membranes to the ends of their formation. The dura mater forms a support which is sufficiently firm and unyielding to retain the brain accurately in its normal position, while its processes are still capable of yielding to a certain extent, like the strong springs of a carriage, under any violent concussion.

The arachnoid, lining the dura mater and covering the surface of the brain, wholly prevents friction, which would otherwise be inevitable, and thus answers, in its situation, the same end as the synovial membranes with their lubricating secretion in the various joints of the body, for the brain is never in a quiescent state, but is constantly rising and falling with a slight pulsating motion.

The immediate agents in the production of these movements appear to be the circulating and respiratory systems, and the motions are

* Loc. cit.

† Translated by M. I. F. South, p. 373, note i.

therefore twofold; the one occasioned by the pulsations of the heart, the other by the movements of the chest; for at the moment that cavity begins to be contracted for the expulsion of the air, the return of the blood from the brain is temporarily impeded; and, on the other hand, when the chest begins to be expanded during inspiration, its flow is in a corresponding degree accelerated. This subject has been much and carefully investigated, as a reference to the following catalogue of authors, who have written expressly on it, given by Meckel, in vol. iii. p. 722, of his Anatomy, will prove. Schlichting, De Motu Cerebri, in the Mém. Prés., tom. i. p. 113; Lorry, Sur les Mouvements du Cerveau et de la Dure-mère, same collection, tom. iii., Mém. i. p. 277, Mém. ii. p. 344; Haller, Experim. ad Motum Cerebri à Refluxu Sanguinis natum, in his Opusc. Phys., tom. i. p. 231; Lamure, Sur la Cause des Mouvements du Cerveau, in the Mém. de Paris, 1753; Richard, in the Jour. de Méd., tom. xxix., 1768, Août, p. 140; Ravina, De Motu Cerebri, in the Mém. de Turin, 1811; Portal, Mém. sur un Mouvement qu'on peut observer dans la Moëlle épinière, in his Mém. sur plus. Maladies, tom. ii. p. 81; Magendie, Sur un Mouvement de la Moëlle épinière isochrone à la Respiration, in his Jour. de Phys. Expér., tom. i. p. 200.

The *pia mater* in the skull is of just sufficient thickness to support the vessels without interfering with the motions of the brain: but in the vertebral canal it is much denser, affording a better support to the cord, and thus performing the same office that the neurilemma, or investing membrane of the nerves, does to these organs in their extended course through all parts of the body.

The *cerebro-spinal fluid* next deserves our attention. The existence and situation of the fluid were first discovered by Haller;* it was more clearly described by Cotunnius, in a memoir entitled "De Ischiade Nervosâ Commentarium," and published subsequently by Sandifort, among other theses. This anatomist was struck with the disproportion of the spinal canal and its contents, and revolved in his own mind how the space was occupied. These statements must have been almost forgotten. Magendie has, however, entered more minutely into the whole physiology of the matter. He first published his discoveries in 1827, in his Journal de Physiologie, and more fully subsequently in 1842, as a separate quarto treatise, with plates. He has shown that if, during life, the arches of the vertebræ are removed in a horse, dog, or other animal, and the dura mater of the spinal cord punctured, there are jets of a fluid, which previously had made the sheath tense. Immediately after death the same may be observed, but in a few hours the greater part of the fluid is imbibed by the surrounding tissues.

The student must have already seen that the brain does not completely fill the cranium, that the spinal cord is very far from occupying the whole vertebral canal. In old persons, particularly in such as have sunk into a state of dementia, the condition of brain is very striking; the convolutions are narrow, and shrunk. The digital fossæ are large, and contain fluid. The seat of this fluid is *not* in the cavity of the arachnoid; there are two distinct localities. First, in the interspace

* Element. Physiolog., vol. iv. p 87.

between the arachnoid and pia mater. Second, in the cavities of the cerebrum and cerebellum in the human subject; and likewise in those of the olfactory nerves, optic lobes, and spinal cord, of some animals.

Thus it will be seen that, closely as the arachnoid in many points resembles the other serous membranes, it differs in this important point—that, instead of adhering closely to the organ it invests, as the pericardium does to the heart, it is separated from the brain by a tolerably wide interspace, in which the fluid is situated.* The whole spinal cord is bathed in this fluid, forming a layer, wider in some parts, narrower in others, according to the shape of the canal and size of the cord in different places. One result of its presence, even in those situations where it is least abundant, is, that the *nerves float* in it, and are thus kept separate from each other, instead of being in close contact, as they appear in the dead subject. In the skull the disposition of the fluid is similar, and the nerves are bathed in it, in their exit from the cranium, as in the spinal canal.

There are some situations where it accumulates in such large quantities, that they may be called *confluences.*

1st. The *largest* and most posterior, situated below and behind the cerebellum.

2d. The *inferior*—Between the crura cerebri.

3d. *Superior*—Above and on the sides of the pineal gland.

4th. *Anterior*—Between the decussation of the optic nerves.

5th. *Lateral*—This bathes the semilunar ganglion of the fifth pair.

It is still a question whether there is any communication between the fluid of the ventricles and the sub-arachnoid. Magendie states "that there is an opening of communication at the calamus scriptorius." Dr. Todd does not believe in the existence of this opening: he says, "It is not necessary to have recourse to such a supposition to account for the transmissibility of fluid from one cavity to another, for the pia mater is evidently hygrometric, and will readily admit of the passage of the fluid through it by endosmose and exosmose."

There is no reason for doubting that this fluid can change its position during life. This fact has not escaped the observation of Dr. Burrowes, who remarks, (p. 50, on Disorders of the Cerebral Circulation, &c., 1846,) "Pathological states of the spinal column in children, and experiments upon animals, afford opportunities for observing the changes in the site of the cerebro-spinal fluid under various modifications of pressure. In spina bifida it may be remarked that the spinal tumor swells and becomes tense during prolonged expiration, as also during fits of coughing and crying. If a graduated pressure be made upon the tumor with one hand, and the fontanelles of the child be examined with the other, in proportion as the spinal swelling decreases, so is a swelling of the brain perceived, accompanied by symptoms which usually result from pressure on the brain and spinal cord."

Magendie, in his estimate of the quantity of this fluid, agrees pretty closely with Cotunnius. It varies according to the age and size of the patient, and usually bears an inverse proportion to the volume of the

* British and Foreign Medical Quarterly Review, October, 1842.

encephalon ; seldom less than two ounces, and often amounting to five. In old age, with atrophy of the brain, to eight, ten, and twelve ounces. Magendie regards the pia mater as the source of the fluid. When this fluid has been removed, the renewal is rapid, as in the case of the humors of the eye, being completely secreted again in twenty-four hours.

The use of this fluid must be obvious to every thoughtful mind. It is a mechanical protection to the brain and spinal cord against the violent shocks and vibrations to which it is occasionally exposed. How different would be the condition of the brain without this soft cushion, or the cord of it hung within the spinal canal, without such a yielding and protecting wall. The poor invalid, whose bones from emaciation are nearly through his skin, will bear his testimony to the value of a fluid couch, if he has had the advantage of being removed from an ordinary bed to Dr. Arnott's water bed. Again, let the medical student enter an anatomical museum, and observe how beautifully the preparations of the spinal cord float in the spirit, unexposed to the shocks and blows to which they would be subject if the fluid were drawn off the bottles, and they were left hanging surrounded merely by the air.

Chemical Analysis of the Cerebro-spinal Fluid, by Lassaigne.

Water	98·564
Albumen	0·088
Osmazome	0·474
Hydrochlorate of soda and potass	0·801
Animal matter and phosphate of soda	0·036
Carbonate of soda and phosphate of lime	0·017
	99·980

Removal of the Brain.—The next step is to remove the brain from the skull, which must be done with great care, as the nerves which are passing from the cavity of the cranium are easily torn through, unless divided with a very sharp knife or pair of scissors.

The fingers of the operator should be insinuated under the anterior lobes, and the cerebral mass raised with great care; the *first* pair of nerves which he will observe are the *olfactory*, running forward to the cribriform plate of the ethmoid bone, from which they must be carefully detached. The next pair are the *optic*, which are observed gliding under the anterior clinoid processes, and quitting the skull at the optic foramina, where they may be divided, as well as the internal carotid arteries, which are situated immediately on their outer side. The next are the *third* or common *oculo-muscular* nerves; these penetrate the dura mater midway between the anterior and posterior clinoid processes. Immediately after their division, a structure, called the *infundibulum*, which runs directly down to the pituitary gland in the sella turcica, must be cut through.

The next pair are the *fourth;* these will be best seen by gently raising the edge of the tentorium ; and being the smallest of the cerebral nerves, they require great care when they are divided. The tentorium itself must next be cut through: and the nerves situated in the fossæ of the

skull under it, will be discovered in the following rotation, namely, the *fifth*, to the outer side of the posterior clinoid processes, just crossing the superior angle of the petrous portion of the temporal bone.

The *sixth*, situated on a plane internal to and beneath the fifth, penetrating the dura mater about half an inch below the posterior clinoid process.

The *seventh* and *eighth*, or facial and auditory nerves, pass on a plane beneath and to the outer side of the fifth, through the foramen auditivum internum.

The *ninth* and *tenth*, or glosso-pharyngeal, and par vagum, with the spinal accessory, are immediately below the last; and the *eleventh*, or lingual, lie rather lower down, but to the inner side. These being divided, the spinal cord and vertebral arteries must be cut through by pushing the knife as low down into the vertebral canal as can be conveniently effected.

The left hand of the operator (his right being engaged in supporting the brain) must then be placed beneath the cerebellum, leaving the spinal cord between his middle and ring finger, and the whole encephalon be removed.*

Removal of the Spinal Cord.—For the purpose of removing the spinal cord, the student had better make an incision through the skin directly over the spinous processes of the whole vertebral column; and next dissecting the muscles from them and the surfaces of the arches, he will be able to use the saw, with which he must cut completely through the arches of the two or three lowermost cervical vertebræ on both sides; having entirely removed these, he can divide the remainder of the arches by means of a strong pair of bone scissors made expressly for the purpose.

Having thus opened the whole of the vertebral canal, he will observe the dura mater completely investing the cord, but not in contact with the arches of the vertebræ, from which it is separated by a layer of soft reddish fat, which is most abundant in the sacral region. The spinal plexus of veins is lodged in this soft bed.

The dura mater forms a complete canal for the medulla spinalis, and also branches off with each of the spinal nerves, which it accompanies as far as the vertebral foramina, to the edges of which it is attached, each attachment performing to the whole the office of ligaments, which retain the cord accurately in its normal situation. At the lower extremity of the vertebral canal in the sacrum, it ends in a bluntish point by fibrous processes which are attached to the os coccygis. These, like the stay-ropes of the mast of a vessel, steady the cord in the interior of its bony case.

The *Arteries*, which are very numerous, are derived from the vertebral, the occipital, deep cervical, intercostal, lumbar and sacral arteries, and supply not merely the membranes, but the substance of the cord. The veins are very numerous and large, forming intricate plexuses, which are more numerous in the cervical and lumbar than in the dorsal region. They have been accurately described and beautifully figured by Breschet; anteriorly they form on the bodies of the vertebræ large sinuses, long known as the longitudinal spinal sinuses. The cross

* These last directions apply only in those cases where the pupil is unavoidably prevented removing the spinal cord in connection with the brain.

branches opposite the centres of the bodies of the vertebræ communicate with long venous canals which traverse the spongy texture of these bones (see fig. 70, 12).

They differ from the sinuses of the brain, in not being enclosed in two layers of the dura mater.

The cord may next be removed in connection with the brain by cutting through the dura mater and each spinal nerve, as it quits the canal, commencing with the lowest sacral, and then drawing it through the foramen magnum.

Having removed the cerebro-spinal axis from its canal, the dissector must proceed carefully to divide the dura mater along the mesial line, and he will then observe the arachnoid loosely investing the cords, and forming, by the addition of some tendinous fibres, a tooth-like ligament between the anterior and posterior roots of each of the spinal nerves, called, from its appearance, the ligamentum denticulatum. This structure is considered by F. Arnold to be formed by processes of the dura mater, similar to those which are met with in the skull. By Dr. Knox it is considered as analogous to certain tendinous shining cords connecting the cerebral arachnoid to the pia mater. To me it appears evidently a continuation of the arachnoid with some superadded fibres, and serves the purpose of hanging the cord to the interior of the canal of the dura mater. It also affords additional protection to the soft and yielding neurine of which the whole spinal nervous mass consists, retaining it in its situation, and supporting, but without exerting the slightest pressure upon it.

The arachnoid being now carefully removed, the dissector will find a tolerably firm membrane underneath it; this is the pia mater, which is so much less vascular than that investing the cortical structure of the brain, that some anatomists have considered it as a distinct membrane. When, however, we consider that the exterior of the cord is formed of medullary, and not of cineritious, neurine, which is so much more vascular, we can understand the reason of the vessels being fewer in number, and thus account for the existence of a pia mater altered in its general appearance.

The pia mater sends processes with the nerves, which, forming their material and investing membrane, constitutes what is called the neurilemma of the nerve. At the inferior extremity of the cord, the pia mater tapers off to a point, and is prolonged as a fibrous string to be inserted into the dura mater. It is called the filiform prolongation of the pia mater. "The late Dr. Macartney," says Dr. Todd,* "used to regard it as highly elastic, but my friend Mr. Bowman has called my attention to the fact, that it consists almost entirely of white fibrous tissue, which cannot confer elasticity; and if a portion removed from the cord be stretched, it will be found to possess very little elasticity; but if the cord be held up by the filiform prolongation, and a slight jerking movement be communicated to it, it may be made to dance about as if by the elastic reaction of the filiform process. The movements which may be thus produced are very well calculated to deceive, and Dr. Macartney must have founded his

* Loc. cit.

opinion upon that experiment alone, omitting to try the effect of stretching a detached portion of the process. The fact is, that when the cord is suspended in this way, the pia mater becomes stretched, and its anterior and posterior portions are approximated and the cord flattened. When it is raised with a jerk, this tension of the pia mater is diminished, and the cord returns to its previous state until it again stretches the pia mater and becomes once more flattened, producing a degree of reaction which favors its elevation, but which alone would be insufficient for that purpose."

Thus, it appears that the elastic reaction which Dr. Macartney attributed to the filiform process, is in reality due to the compression and consequent flattening of the cord by the tension of the pia mater. It should be stated further, that this process is not formed of pia mater alone, but also of a continuation of the ligamentum denticulatum on each side.

PART IV.

WEIGHT OF THE HUMAN BRAIN.

In tracing the gradual development of the nervous system of the animal kingdom up to man, the student will have observed, in all the specimens ordinarily within his reach, the actual inferiority as regards size and weight of the brain, even of the higher animals, as compared with man. The brain of the horse, for instance, is not merely smaller relatively to the body than that of the human being, but actually so. Indeed, the only exception to this rule is met with in the brain of the elephant and the whale—the brain of the elephant weighing from 8 to 10 lbs.; and, according to Rudolphi, that of a whale, 75 feet long, (*Balæna mysticetus*,) weighed 5 lbs. $10\frac{1}{4}$ oz., but that of a narwhal, 17 to 18 feet long, (*Monodon monoceros*,) only 2 lbs. 3 oz.

It is to be remembered that these observations apply to the encephalon, the whole brain, and not to the hemispherical ganglia, which we believe to be the portion immediately connected with the intellectual powers.

Agreeing with Professor Müller, that all the primitive fibres of the nerves of volition and of sensation are actually continued into the brain, I believe that the great bulk of the brain of brutes is made up of the fibrous neurine which traverses their body in the form of nerves. At the same time it is to be remembered that the great bulk of the nerves of animals is composed of strong membranous envelops to each fibre, and not solely of neurine. The increase of size which is thus given to a nerve is well seen in the portio dura or facial nerve of the human subject. Compare this nerve at its origin in the medulla oblongata, before it can receive a covering from the pia mater, and the same nerve after it has quitted the skull by the stylo-mastoid foramen.

Many observations have been made on the weight of the human brain, from the time of Haller to the present period; the latest and most extensive are by that indefatigable and excellent physiologist, Dr. John Reid, published in the London and Edinburgh Monthly Journal of Medical Science for April 1843. Dr. Sims, who has an excellent paper on Atrophy and Hypertrophy of the Brain, in vol. xix. of the Medico-Chirurgical Transactions, after giving the conclusions of Haller, Soemmerring, and Sir Wm. Hamilton, gives tables of his own. From these sources we learn that the average weight of the adult human male brain is about 3 lbs. That it increases from 1 year old up to 20. Between 20 and 30 there is a slight decrease on the average; afterwards it increases, and arrives at its maximum between 40 and 50; to old age the brain gradually decreases in weight. Tiedemann, in his paper

on the brain of the negro,* states that the brain of the adult male varies between 3 lbs. 2 oz. and 4 lbs. 6 oz. The brain of men who have distinguished themselves by their talents, is often large; the brain of Cuvier weighed 4 lbs. 11 oz. 4 dr. 30 gr. troy weight; that of Dupuytren 4 lbs. 10 oz. troy weight. The brain of an idiot, 50 years of age, weighed only 1 lb. 6 oz. 4 dr.; and another, 40 years of age, weighed but 1 lb. 11 oz. 4 dr. The female brain usually is lighter than the male. It varies between 2 lbs. 6 oz. and 3 lbs. 11 oz. Tiedemann never met with a female brain that weighed 4 lbs. The female brain weighs on an average from 4 to 6 ounces less than that of the male; and this difference is already perceptible in the new-born child.

It is curious that Rudolph Wagner, whose name as a physiologist stands deservedly high, should make the following statement regarding the growth of the brain:†—"With the second dentition in the course of the seventh and eighth years, the brain seems to attain its complete development in point both of form and weight, and its several parts now represent the relations which they preserve through the whole of after-life." Dr. Willis has the following excellent observations on this passage:—"This is surely a physiological error; on taking measurements of the heads of fifteen children, between 7 and 8 years of age, I find the mean circumference to be $20\frac{1}{2}$ inches; but the mean circumference of the head in ten children between 13 and 14 years of age in the same school, taken as they stood, and without selection, is $21\frac{1}{2}$ inches. If the size of the skull represent the size of the brain, therefore, the brain is not so large at 8 years of age as it is at 14; neither is it so large at 14 or 15 as it is at 20 and 25. On making the inquiry at several of the large hat shops of the metropolis, whether or not there was any difference in the sizes of hats required for boys of between 7 and 8 years of age, and full-grown men, I was assured there was a very considerable difference: that the sizes of youths of 7, 8, and 9, were what are designated the $6\frac{1}{2}$, $6\frac{5}{8}$, and $6\frac{6}{8}$ sizes, whilst for grown men the mean average size is about 7, or from that to $7\frac{1}{8}$. The numbers here represent the mean between the long and the lateral diameters of the head. A London hatter says: 'The head I have always found to attain its full dimensions in accordance with the bodily frame. I fix the utmost limit my experience will allow at 25 years. The more general period of full attainment of size is between 17 and 23. Many heads are at their full size at the age of 16.'"

The Tables which follow over leaf are from Dr. Reid.

* Phil. Trans., 1836.

† Op. cit., p. 616.

TABLE I.

Weight used Avoirdupois.

Exhibiting the Heaviest, Lightest, and the Average Weight of Encephalon, Cerebellum, and Cerebellum with Pons Varolii and Medulla Oblongata, at different ages, in 253 Brains. Though individual female brains are not unfrequently found to be heavier than individual male brains, yet as the average male brain is several ounces heavier than the average female brain, it is necessary that these be ranged in separate tables;—the more especially when the number of brains at different ages, weighed in the two cases, do not correspond.

	Age.	Number weighed.	Heaviest.			Lightest.			Average.		
			Encephalon.	Cerebellum.	Cerebellum with pons and medulla.	Encephalon.	Cerebellum.	Cerebellum with pons and medulla.	Encephalon.	Cerebellum.	Cerebellum with pons and medulla.
	Years.		oz. dr.	oz. dr.	oz. dr.	oz. dr.	oz. dr.	oz. dr.	oz. dr.	oz. dr.	oz. dr.
MALES.	1—4	5	45 4	4 10	5 6	27 8	2 8	3 0	39 $4\frac{2}{5}$	3 $13\frac{1}{5}$	4 $6\frac{2}{5}$
	5—7	3	47 $10\frac{1}{2}$	5 1	6 0	40 12	4 0	4 9	43 10	4 7	5 6
	7—10	6	52 14	5 0	5 11	40 12	4 0	4 10	46 $2\frac{4}{6}$	4 $10\frac{2}{5}$	5 $10\frac{6}{7}$
	10—13	3	51 2	5 2	6 2	43 8	4 9	5 6	48 $7\frac{1}{3}$	4 14	5 12
	13—16	5	50 2	5 8	6 8	43 10	0 0	5 10	47 $8\frac{2}{5}$	—	6 $1\frac{1}{2}$
	16—20	6	56 0	6 1	7 2	48 0	4 8	5 8	52 $10\frac{2}{3}$	5 $4\frac{1}{2}$	6 $6\frac{2}{10}$
	20—30	25	58 0	6 0	7 0	45 8	4 12	5 4	50 $9\frac{1}{2}$	5 $3\frac{1}{2}$	6 2
	30—40	23	62 8	5 14	8 8	40 10	4 6	5 1	51 $15\frac{1}{2}$	5 $3\frac{1}{2}$	6 $4\frac{1}{2}$
	40—50	34	53 8	6 4	7 10	34 0	4 8	5 6	48 $13\frac{1}{2}$	5 $3\frac{2}{6}$	6 $4\frac{6}{11}$
	50—60	29	59 0	7 0	8 4	39 0	4 8	5 4	50 2	5 $5\frac{8}{18}$	6 $2\frac{2}{28}$
	60—70	8	60 4	6 3	7 4	40 0	4 2	5 2	50 $6\frac{6}{8}$	5 0	6 2
	70 and upwards	7	54 10	5 8	6 8	43 8	4 8	5 4	48 $4\frac{2}{7}$	4 14	5 $14\frac{4}{7}$
	Total male brains weighed	154									
FEMALES.	2—4	6	42 0	4 0	4 10	32 0	3 5	3 15	37 9	3 $9\frac{8}{10}$	4 5
	5—7	3	41 8	4 0	4 8	36 0	3 5	4 0	39 $1\frac{1}{3}$	3 11	4 $8\frac{2}{3}$
	7—8	3	43 14	4 10	5 9	40 8	4 4	5 0	42 $7\frac{1}{3}$	4 $7\frac{4}{6}$	5 5
	10—13	1	43 8	5 2	6 2	—	—	—	—	—	—
	13—16	1	41 0	4 8	5 8	—	—	—	—	—	—
	16—20	8	49 12	5 8	6 4	41 8	4 12	5 6	44 $11\frac{1}{2}$	4 $14\frac{1}{6}$	5 $11\frac{12}{14}$
	20—30	18	50 0	5 2	6 2	39 2	4 0	4 12	45 $2\frac{2}{9}$	4 $11\frac{1}{3}$	5 $9\frac{1}{3}$
	30—40	23	51 0	5 8	6 8	39 14	4 2	5 0	44 $1\frac{1}{2}$	4 $13\frac{1}{5}$	5 11
	40—50	18	50 6	6 0	7 0	36 12	3 12	4 4	44 $10\frac{4}{9}$	4 14	5 $14\frac{4}{7}$
	50—60	5	48 6	4 12	5 15	43 4	4 4	5 2	45 $4\frac{4}{5}$	4 $7\frac{1}{2}$	5 $8\frac{2}{5}$
	60—70	1	46 10	5 2	6 0	36 2	4 2	5 0	42 $14\frac{6}{7}$	4 $10\frac{2}{11}$	5 9
	70 and upwards	2	46 0	5 1	6 0	31 1	3 10	4 5	38 $8\frac{1}{2}$	4 $5\frac{1}{2}$	5 $2\frac{1}{2}$
	Total female brains weighed	99									

An examination of Table I. does not afford any support to the supposition of some, that the cerebellum attains its maximum weight at seven years of age, and the cerebrum its maximum weight nearly at the same period, or only a little later. There appears to be little doubt, however, from all the facts which have been collected on this subject, that the brain arrives at its maximum weight sooner than the other organs of the body, and to judge from a few measurements we have made of the length of the corpus callosum, the depth of the gray matter, the length, breadth, and depth of the corpus striatum and thalamus, we would be

inclined to conclude that the relative size of these parts is the same in the young person as in the adult. We believe that there can be little doubt that the relative size of the brain to the other organs, and to the entire body, is much greater in the child than in the adult. In Table III. will be found the results we have obtained on this point. In Table II. we find less difference between the relative weight of the encephalon and cerebellum, at different periods of life, than we had been led to expect from some statements which havebeen made upon this question. The data we have collected do not entitle us to speak positively, but as the other statements to which I refer seem principally to rest upon the vague and uncertain measurements of the eye, we may reasonably request to be allowed to suspend our opinion of their accuracy, until we have a sufficient amount of materials brought before us to justify us in giving a decided judgment. In looking over the column of the average weights of the encephalon, at different ages, in Table I., we cannot fail to experience some surprise at the difference between the average weight of that organ in the male, between 16 and 20 years of age and between 40 and 50, but we cannot for a moment have any hesitation in deciding that this must arise from sources of fallacy incident to insufficient data. In the group between 40 and 50 years of age some brains much below the average weight are found, and there can be no doubt that it is to this accidental circumstance that we must attribute the diminution in the average weight of the brain in that group. Among the females, we find a decided diminution in the average weight of the brain above 60 years of age, while, among the males, this is not apparent until a later period. We certainly did expect also to find a similar diminution in the average weight of the male brain above 60 years of age, for we are perfectly satisfied, as the tables containing the individual facts will show, that we more frequently meet with a greater quantity of serum under the arachnoid and in the lateral ventricles in old people, than in those in the prime of life. We are also satisfied, from an examination of the notes we have taken at the time the brains were examined, that a certain degree of atrophy of the convolutions of the brain over the anterior lobes, marked by the greater width of the sulci, was more common in old than in young persons. We have, however, frequently remarked these appearances in the brains of people in the prime of life, who had been for some time addicted to excessive indulgence in ardent spirits.

TABLE II.

Relative Weight of Encephalon to Cerebellum, and to Cerebellum with Pons Varolii and Medulla Oblongata, at different ages, in 172 bodies.*

	MALES.				FEMALES.			
Ages.	Cerebellum	Number weighed	Cerebellum with pons Varolii and medulla.	Number weighed.	Cerebellum	Number weighed.	Cerebellum with pons and medulla oblongata	Number weighed.
1 to 5 years	1 to $10\frac{2}{5}$	5	1 to $8\frac{15}{16}$	5	1 to $9\frac{9}{10}$	4	1 to $8\frac{10}{17}$	5
5 7 "	1 $9\frac{9}{10}$	3	1 $8\frac{1}{6}$	3	1 $10\frac{7}{10}$	2	1 $8\frac{3}{5}$	3
7 10 "	1 $9\frac{5}{12}$	5	1 $8\frac{1}{23}$	5	1 $9\frac{1}{2}$	3	1 8	3
10 13 "	1 $9\frac{20}{23}$	3	1 $8\frac{5}{12}$	3	—	—	—	—
13 15 "	1 $9\frac{1}{11}$	1	1 $7\frac{13}{15}$	4	—	—	—	—
16 20 "	1 $9\frac{15}{17}$	4	1 $8\frac{7}{16}$	4	1 $9\frac{1}{19}$	5	1 $7\frac{3}{4}$	5
20 30 "	1 $9\frac{11}{18}$	13	1 $8\frac{1}{6}$	13	1 $9\frac{9}{25}$	12	1 8	12
30 40 "	1 $9\frac{15}{23}$	11	1 $8\frac{7}{45}$	11	1 $9\frac{6}{11}$	15	1 $8\frac{1}{17}$	15
40 50 "	1 $9\frac{8}{18}$	23	1 8	23	1 $9\frac{1}{9}$	9	1 $7\frac{20}{27}$	9
50 60 "	1 $9\frac{11}{16}$	17	1 $8\frac{1}{8}$	17	1 10	4	1 $8\frac{2}{7}$	4
60 70 "	1 $10\frac{4}{13}$	5	1 $8\frac{1}{4}$	8	1 $9\frac{8}{30}$	11	1 $7\frac{24}{32}$	11
70 & upwards	1 $9\frac{3}{8}$	5	1 $8\frac{1}{6}$	7	1 $8\frac{12}{13}$	2	1 $8\frac{2}{25}$	2
$2\frac{1}{2}$ years	—	—	—	—	1 $10\frac{1}{22}$	4	1 $8\frac{1}{2}$	4†
4 months	1 11	1	1 $9\frac{1}{6}$	1	—	—	—	—
1 year	1 $9\frac{15}{16}$	1	1 $8\frac{15}{18}$	1	—	—	—	—

* In ascertaining the relative weight of the cerebellum to the encephalon, those encephala only were selected in which the cerebella were also weighed. The same plan was also followed in ascertaining the relative weight of the cerebellum with pons and medulla oblongata to the encephalon.

† Three of the youngest cases included in the above Table given separately.

TABLE III.

Relative Weight of entire Body to Encephalon, Cerebrum, Cerebellum, Cerebellum with Pons Varolii and Medulla Oblongata, Heart, and Liver, in 92 Bodies. In this and in all other similar Tables, I have selected those cases only in which all the organs whose relative weight is given were weighed in the same individual.

Ages.	Body to encephalon.	Number weighed.	To cerebrum.	Number weighed.	To cerebellum.	Number weighed.	Cerebellum with pons Varolii and medulla.	Number weighed.	To heart.	Number weighed.	To liver.	Number weighed.
1 to 5 years	1 to $8\frac{1}{2}$	4	1 to $9\frac{6}{10}$	4	1 to $88\frac{1}{3}$	4	1 to $76\frac{1}{3}$	4	1 to $176\frac{3}{4}$	4	1 to $21\frac{2}{9}$	5
at 5 "	1 $9\frac{15}{19}$	2	1 $10\frac{4}{27}$	2	1 $97\frac{4}{9}$	2	1 $81\frac{3}{33}$	2	1 $130\frac{8}{15}$	2	1 $23\frac{12}{16}$	2
at 7 "	1 $10\frac{24}{71}$	2	1 $11\frac{12}{17}$	2	1 $107\frac{4}{7}$	2	1 $93\frac{21}{23}$	2	1 $175\frac{1}{3}$	1	1 21	1
13 to 15 "	1 $15\frac{10}{14}$	3	1 $21\frac{18}{21}$	3	1 $142\frac{12}{22}$	1	1 $146\frac{3}{7}$	3	1 $176\frac{12}{16}$	2	1 $25\frac{24}{28}$	2
20 30 "	1 $35\frac{42}{44}$	11	1 $40\frac{27}{38}$	11	1 $352\frac{12}{20}$	10	1 $293\frac{12}{27}$	11	1 $173\frac{5}{7}$	13	1 $29\frac{3}{5}$	6
30 40 "	1 $37\frac{6}{11}$	6	1 $41\frac{2}{25}$	5	1 $342\frac{11}{21}$	5	1 $306\frac{15}{19}$	6	1 $165\frac{25}{27}$	6	1 $35\frac{1}{2}$	7
40 50 "	1 38	14	1 $42\frac{19}{41}$	12	1 $348\frac{1}{27}$	12	1 $295\frac{8}{11}$	12	1 $169\frac{8}{9}$	11	1 $35\frac{4}{6}$	14
50 60 "	1 $36\frac{5}{7}$	11	1 $42\frac{1}{3}$	10	1 $370\frac{1}{3}$	8	1 $318\frac{5}{7}$	10	1 $165\frac{4}{11}$	15	1 $35\frac{1}{4}$	4
60 70* "	1 $39\frac{1}{5}$	4	1 $44\frac{1}{6}$	4	1 $427\frac{1}{3}$	4	1 $348\frac{1}{2}$	4	1 137	3	1 $43\frac{3}{9}$	2
2 4 "	1 $8\frac{5}{9}$	4	1 $9\frac{7}{10}$	4	1 $84\frac{1}{14}$	4	1 $71\frac{11}{12}$	4	1 $151\frac{1}{10}$	6	1 20	5
5 7 "	—	—	—	—	—	—	—	—	—	—	—	—
7 10 "	1 $13\frac{1}{23}$	3	1 $15\frac{1}{13}$	3	1 125	3	1 $105\frac{10}{25}$	3	—	—	1 $22\frac{1}{4}$	1
13 15 "	1 22	—	—	—	—	—	—	—	—	—	—	—
16 20 "	1 $30\frac{1}{2}$	3	1 $31\frac{9}{12}$	3	1 $283\frac{1}{3}$	3	1 $181\frac{1}{3}$	3	1 181	4	1 $30\frac{5}{12}$	4
20 30 "	1 $33\frac{4}{23}$	4	1 $37\frac{3}{4}$	4	1 $327\frac{1}{15}$	4	1 $275\frac{1}{2}$	4	1 $183\frac{13}{14}$	7	1 $33\frac{2}{7}$	5
30 40 "	1 $34\frac{6}{9}$	8	1 $39\frac{3}{7}$	6	1 $316\frac{2}{5}$	5	1 $285\frac{3}{4}$	6	1 $173\frac{3}{4}$	5	—	—
40 50 "	1 35	5	1 $41\frac{2}{5}$	4	1 $324\frac{6}{13}$	4	1 $277\frac{1}{2}$	4	1 $174\frac{1}{6}$	6	1 $42\frac{1}{6}$	4
50 60 "	1 $38\frac{1}{53}$	2	1 $41\frac{1}{2}$	2	1 $370\frac{1}{11}$	2	1 $307\frac{55}{83}$	2	—	—	—	—
60 and upwards	1 $38\frac{1}{5}$	6	1 $43\frac{1}{5}$	6	1 $346\frac{1}{3}$	6	1 $288\frac{7}{10}$	6	1 $180\frac{11}{27}$	4	1 $25\frac{1}{4}$	2

* One of these was above 70 years of age.

TABLE IV.

Average weight of the Encephalon, &c., between 25 and 55 years of age, in the two sexes, and the average difference between them.
Males, 53 brains weighed.—Females, 34 brains weighed.

	Male. oz. dr.	Female. oz. dr.	Difference in favor of the Male. oz. dr.
Average weight of Encephalon	50 $3\frac{1}{2}$, or 3 lbs. 2 oz. $3\frac{1}{2}$ dr.	44 $8\frac{1}{2}$, or 2 lbs. 12 oz. $8\frac{1}{2}$ dr.	5 11
.. .. Cerebrum - - - - - -	43 $15\frac{3}{4}$	38 12	5 $3\frac{3}{4}$
.. .. Cerebellum - - - -	5 4	4 $12\frac{1}{4}$	0 $7\frac{3}{4}$
.. .. Cerebellum with pons and medulla oblongata	6 $3\frac{3}{4}$	5 $12\frac{1}{3}$	0 $7\frac{1}{2}$ nearly.

TABLE V.

Relative weight of Encephalon to Cerebellum, and to Cerebellum with Pons Varolii and Medulla Oblongata, between 25 and 55 years of age, in the two sexes.
53 male, and 34 female brains weighed.

	Male.	Female.
Relative weight of Encephalon to cerebellum - - - - - -	as 1 to $9\frac{4}{7}$	as 1 to $9\frac{1}{4}$
.. Encephalon to cerebellum with pons and medulla	1 $8\frac{8}{13}$	1 $7\frac{9}{10}$

From this table it would appear that, in the female, the average cerebellum is relative to the encephalon, a little heavier than in the male.

TABLE VI.

Relative Weight of the entire Body to the Encephalon, the Heart, and Liver, in the two sexes between 25 and 55 years of age.

	Encephalon.	Number weighed.	Heart.	Number weighed.	Liver.	Number weighed.
Male - - -	as 1 to $37\frac{1}{2}$	33	as 1 to $169\frac{1}{2}$	37	as 1 to $35\frac{1}{3}$	31
Female - -	1 35	15	1 176	12	1 39	7

As far as this Table enables us to judge, it would appear that though the average male brain is absolutely heavier than that of the female, yet that the average female brain, relative to the weight of the whole body, is somewhat heavier than the average male brain.

TABLE VII.

In 9 Males, between 27 and 50 years of age, who died either immediately, or within a few hours after accidents and other external causes of sudden death, and who had been previously in good health, the following results were obtained:

Average weight of body (9 weighed).	Average of encephalon (6 weighed).	Average of cerebellum (4 weighed).	Average of cerebellum with pons and medulla (5 weighed).	Average of heart (9 weighed).
	oz. dr.	oz. dr.	oz. dr.	oz. dr.
9st. 8 lbs., $3\frac{1}{2}$ oz., or 134 lbs. $3\frac{1}{2}$ oz.	52 $4\frac{4}{6}$, or 3lbs. 4 oz. $4\frac{4}{6}$ dr.	5 $7\frac{1}{6}$	6 6 or, taking the average of the four cases only in which the cerebellum was taken, 6 oz. $7\frac{7}{8}$ dr.	12 6

Relative weight of body to encephalon (6 weighed) - - - - - -	as 1	to $40\frac{4}{5}$
.. .. to heart (9 weighed) - - - - - - - -	1	$173\frac{1}{3}$
.. encephalon to cerebellum (4 weighed) - - -	1	$9\frac{2}{5}$
.. .. to cerebellum with pons and medulla (5 weighed)	1	$8\frac{6}{19}$

Though the data from which the above Table is constructed are very limited, yet we may be allowed to remark, that the greater relative weight of the encephalon to the body, in those emaciated by disease, than in those cut off while in possession of health and muscular vigor, which it indicates, is what we would expect from other considerations. There is little difference in the relative weight of the cerebellum to the encephalon in the two classes of cases.

My friend and colleague, Dr. T. B. Peacock, has also published some admirable tables in the Monthly Journal of Medical Science, for 1846, from which he draws the following conclusions:—

"1st. The encephalon in the adult male weighs, on an average, 50 oz. 3·25 dr., or 3 lb. 2 oz. and $3\frac{34}{131}$ drachms avoirdupois, and exceeds in weight that of the female by 5 oz. 4·95 dr., the latter weighing on an average 44 oz. and 14·3 dr., or 2 lb. 12 oz. $14\frac{28}{74}$ dr.

"Of 131 male brains weighed, the heaviest was 62 oz. 12 dr., or 12 oz. 8·75 dr. above the mean; the lightest was 34 oz., or 16 oz. 3·25 dr. below it.

"Of 74 female brains, the extremes were 54 oz., or 9 oz. 1·7 dr. above the average, and 36 oz. 12 dr., or 8 oz. 2·3 dr. below it.

"Of the male encephala, 8·3 per cent. were under 45 oz. in weight, 74·04 per cent. weighed between 45 and 55 oz., and 17·5 per cent. exceeded 55 oz. in weight.

"Of the female encephala, 54 per cent. weighed under 45 oz., 45·9 per cent. were between 45 and 55 oz. in weight, and none exceeded 55 oz.

"*Note.*—A comparison of these averages with those deduced by Dr. Reid, will show that they correspond very closely, though the numbers on which the calculations are based are considerably extended. They do not differ, also, very greatly from the conclusions of Sir William Hamilton, Dr. Sims, and Dr. Clendenning. Sir W. Hamilton estimated the weight of the adult male encephalon at 3 lb. 8 oz. troy, and the female at 3 lb. 4 oz., which are nearly 48 oz. 5 dr., and 43 oz. 15 dr. avoirdupois. On calculating the weights of the brain in the two sexes separately, from the observations published by Dr. Sims, I find the male brain, in 54 persons between 20 and 60 years of age, to average 47 oz. 13 dr., and the female brain in 58 persons, 44 oz. and 10 dr. Dr. Clendenning states the male brain in persons between 21 and 60 years of age to average 45·85 oz., and the female 41·25 oz. These several averages, together with those deduced by Professor Reid and myself, range between $45\frac{3}{4}$ oz. and $50\frac{1}{4}$ oz. for the male, and $41\frac{1}{4}$ oz. and nearly 45 oz. for the female.

"Tiedemann,* whose actual observations amount to only 52 (35 males and 17 females), states the weight of the adult European encephalon to vary in the male between 3 lb. 2 oz. and 4 lb. 6 oz. troy, or 41 oz. 12 dr. and 59 oz. 5 dr. avoirdupois, and in the female, between 2 lb. 8 oz. and 3 lb. 11 oz. troy, or 35 oz. 2 dr. and 51 oz. 11 dr. avoirdupois.

"The want of accurate information, as to the number of observations on which their calculations are based, of the weights employed, and of the ages of the persons, render the statements of the older anatomists, as to the weight of the encephalon, of little value. Soemmerring states—'Cerebrum et cerebellum, resecta medulla spinali statim pone nervum lingualem medium pondo sunt librarum duarum ad tres libras; sunt enim alia cerebra pondere librarum duarum et unciarum quinque cum dimidia, alia librarum trium et unciarum trium cum tribus quartis. Aliis (referring to the weights of brain assigned by Haller, Elementa Physio-

* Phil. Trans., vol. cxxvii. p. 497.

logiæ, t. iv., p. 10) observata sunt cerebra libræ unius cum dimidia, aliis pondus librarum quinque superantia, quod posterius vero haud verisimile videtur, nisi forte diverso hexagio res rite interpretari possit.' (De corporis humani fabrica, t. iv., f. 38.) He adds, in a note, 'In universum quidem Hallerus cerebrum pondere esse librarum quinque autumat, rectius certe quatuor, si de pondere pharmaceutico Germanico sermo est. Certe enim inter plura quam ducenta cerebra à me disquisita nullum inveni quod quatuor sit librarum.' From this it appears that Soemmerring employed the German or Nuremberg pound of 5524·8 grains, and the weights which he gives consequently vary between 31 oz. and 41 oz. and 14 dr. avoirdupois, much below the estimates of more recent observers; but as he imagined the brain to attain its full development at 3 years of age, and has not specified that the weights referred to were those only of adults, we may infer that he included in his calculation the brains of persons in early life. The estimate of the Wenzels seems more nearly correct:—'Pondus encephali humani, quale id de quinto vitæ anno ad summam usque hominis senectutem plerumque invenitur, pondus viginti quatuor millium granorum non superat. * * * Totius cerebri pondus inter viginti et viginti duo millia; cerebri strictius dicti inter octodecem et viginti millia granorum plerumque variat.'—(De penitiori structura Cerebri Hominus et Brutorum, f. 267.) The weight of the encephalon thus given, is from 45 oz. 12 dr. to 50 oz. 5 dr. avoirdupois; and, as including persons in early and advanced life, and of both sexes, is sufficiently exact. The weight of the encephalon is estimated by Portal at 48 oz. 3½ dr. avoirdupois; and by Meckel, if his weight be the German lb., at 43 oz. and 11 dr. avoirdupois. M. Lélut* estimates the weight of the encephalon of the male adult at 1320 grammes, or 46 oz. 10 dr. avoirdupois; and M. Parchappé† at 1323 grammes, or 46 oz. 11 dr.; and that of the female at 1210 grammes, or 42 oz. 11 dr. avoirdupois.

"2d. The human encephalon appears ordinarily to attain its maximum of development at from the 20th to the 25th year; throughout the middle period of life it displays little variation, but a very marked decrease in weight obtains in advanced age. This conclusion is uniformly borne out by the weights of the encephalon at different ages in both sexes; nor do the tables afford any support to the opinions of Soemmerring, the Wenzels, and Sir W. Hamilton, that the brain arrives at perfection in or before the 7th year. Though it may occasionally happen that the brain of a person in early life shall be found as heavy as are ordinarily the brains of adults, yet the average of the weights of several brains between 10 and 20 years of age, is uniformly less than that afforded by the brains of persons between 25 and 55 years of age.‡

"*Note.*—The gradual increase in the weight of the encephalon up to adult age, accords with the conclusions of Dr. Sims, and with the views

* Gazette Médicale de Paris, 2me série, t. v., 1837, p. 146.

† Ibid. See also M. Parchappé's Memoir, t. x. 1842, p. 650, where he gives the weight of the encephalon in males, 1352 grammes; and in females, 1229.

‡ These results accord with Dr. Reid's previous inferences. The decrease in the weight of the encephalon in advanced life, is, it will be observed, much more marked in females than in males.

of Gall and Spurzheim. Soemmerring, however, from one observation, inferred that the brain attained its full weight at three years of age, and the Wenzels at 7. The latter age has also been regarded by Sir W. Hamilton as the probable term of growth of the brain. The present observations further confirm the inference, that, contrary to the supposition of the Wenzels and Sir W. Hamilton, the encephalon decreases in weight in advanced life. In reference to Sir W. Hamilton's observations, it may be remarked that the actual weights of human brains can alone form just data for conclusions; and that it seems scarcely possible that any method of ascertaining the size of the brain from examination of the skull can be free from fallacy*—an objection especially applicable to estimates so formed of the weight of the brain in advanced age, when, as is well known, the ventricular cavities and subarachnoidal cellular tissue often contain much fluid.

"3d. The excess of weight of the male over the female encephalon, is observed at an early age, and continues throughout the course of life. This inference is applicable after the commencement of the second year; before that period the data are too imperfect to allow of any conclusions being founded upon them.

"4th. The average weight of the cerebrum in adult males, is 44 oz. 3·4 dr., and in females, 39 oz. 3·3 dr.; the cerebrum of the male, therefore, exceeds in weight that of the female by 5 oz. 0·1 dr.

"5th. The cerebellum, with the pons Varolii, and medulla oblongata, averages in adult males, 6 oz. 40·5 dr.; in females, 5 oz. 10·5 dr.—the excess in the male being 9·55 dr.

"6th. The cerebellum alone, calculated from Professor Reid's observations, averages in the adult male 5 oz. 2·6 dr., and in the female 4 oz. 12·4 dr.—the difference being 6·2 dr.

"7th. It has been seen that the encephalon may be regarded as attaining its maximum of development at from the 20th to the 25th year, and declines in weight in advanced life. The same law obtains in reference to the development and decline of its several portions. It would, however, appear probable that the cerebellum, with the pons Varolii and medulla oblongata, arrive at their full growth somewhat earlier than the cerebral hemispheres. This surmise is supported by the weights of the former portions of the brain between 10 and 20 years of age, exceeding in females their weight in the adult, and being in males very slightly less than their weight in the adult. The results given in the tables are, however, unfavorable to the idea of Sir W. Hamilton, that the cerebellum attains its maximum of development at about the 7th year—an opinion opposed also by the weights of the cerebellum alone, as given by Professor Reid.

"8th. The excess which obtains in the weight of the encephalon of the male over that of the female, exists also in each of the several portions of the brain—the cerebrum, the cerebellum, with the pons Varolii and medulla oblongata, and the cerebellum alone, being uniformly heavier

* Sir W. Hamilton states his observations to have been founded "on inductions from above 60 human brains, and from nearly 300 human skulls of determined sex, the capacity of which, by a method I devised, was taken in sand, and the original weights of the brain thus recovered."—*Monro's Anatomy of the Brain*, 1831.

in the male than in the female. The excess in the weight of each of these portions of the brain in the male over their weight in the female, maintains a very similar ratio, a fact opposed to the conclusion of Sir W. Hamilton, 'that almost the whole difference in the weight of the male and female encephali lies in the brain proper, the cerebella of the two sexes absolutely being nearly equal; the preponderance being rather in favor of the female.'

"9th. The relative proportion of the encephalon to the whole body undergoes a gradual decrease from infancy to adult age; and averages in males, at from 25 to 55 years of age, 1 to 37·2, presenting during this period a range of from 1 to 79·98 to 1 to 25·2, according to the state of emaciation or corpulence of the body weighed.

"In females the average during adult life is 1 to 33·5, and the extremes 1 to 44·8 and 1 to 24·1. It will be seen that, as before remarked by the Wenzels and Tiedemann, the female brain, though absolutely lighter than that of the male, maintains a higher proportion relatively to the weight of the body.

"10th. The proportions, relatively to the whole body, of the cerebellum with the pons Varolii and medulla oblongata, and of the cerebellum alone (as shown by Dr. Reid's observations), also gradually decreases from infancy, and at adult age the former averaged in males 1 to 277·1, presenting the extremes of 1 to 424·7 and 1 to 244·5.

"The proportion in adult females is 1 to 290·7, and the extremes 1 to 326· and 1 to 213·3.

"Tiedemann found the relative proportion of the encephalon to the body in adults as 1 to 35 and 1 to 45, and the extremes 1 to 22 and 1 to 50 to 100.

"11th. The proportion which, in the adult, the cerebellum with the pons Varolii and medulla oblongata bear to the whole encephalon, is 1 to 7·8, and is nearly the same in the two sexes, being as 1 to 8·057 in the male, and 1 to 7·87 in the female.

"Dr. Reid had been led to infer that the cerebellum with the pons Varolii and medulla oblongata was relatively to the encephalon heavier, in a somewhat higher proportion, in the female than in the male, being as 1 to 7·9 and 1 to 8·6 respectively. His calculations are, however, founded on the weights of 53 male and 34 female brains, while the present tables include 96 and 58 weights. From my own observations separately, the proportions are as 1 to 7·98 in females, and 1 to 7·93 in males.

"12th. The ratio of the weight of the cerebellum alone to that of the whole encephalon, is, in the male, between 25 and 55 years of age, 1 to 9·58, and in the female 1 to 9·34.

"13th. The relative proportion of the cerebellum to the cerebrum in adults of the two sexes, as calculated from Dr. Reid's data, is in males 1 to 8·37; in females 1 to 8·28. Sir W. Hamilton states, 'that the cerebellum in the female is in general considerably larger in proportion to the brain proper than in the male; in the female it is as 1 to 7·6, in the male as 1 to 8·4.' The calculations now given show the weights of the cerebellum with the pons Varolii and medulla oblongata, and of the cerebellum alone, to be, relatively to that of the whole encephalon, somewhat higher in females than in males. This inference is not,

however, confirmed by the observations of M. Parchappé ; and the difference which, from the present data, appears to exist, is much less than was supposed by Sir W. Hamilton. It is, therefore, very questionable how far the excess of weight in females can be regarded as constituting a general rule.

"14th. Though the data now published are defective in weights of the whole encephalon and its several portions, in infants and young persons, they render it most probable that the ratio of the cerebellum alone or with the pons Varolii and medulla oblongata, to the cerebrum and encephalon, undergoes but little change during the whole period of life, after the expiration of the first year. Further observations are required on this point;—the facts at present recorded are, however, opposed to the surmise, that the cerebellum attains its complete state of development at a period much anterior to that of the rest of the brain."

PART V.

CONFIGURATION OF THE ENCEPHALON.

Before the student begins to trace the medullary fibres of the cerebro-spinal axis, in order to ascertain the connections and relations of one part with another, as well as those of the cineritious with the medullary neurine, it will be desirable to take a general view of the external form and appearance of the entire brain and spinal cord. He will thus become acquainted with the different elevations and depressions observable on its surface. Our predecessors, till lately, confined their attention almost entirely to external appearances, and to such as are produced by section, and obtained but an imperfect idea of the real structure of the organ; but we must not fall into the opposite error, and neglect the observation of outward form as wholly unnecessary or unphilosophical. We must only be on our guard at the same time not to confound the study of mere outward configuration with a knowledge of internal structure.

In studying the configuration of the cerebral mass, we shall find it advantageous to divide its surface into two portions, the one external and *convoluted*, the other internal, which presents appearances of so precise a form that it may be called the *figurate;* the convoluted, as will be explained afterwards, forming a sort of envelop or wrapper to the figurate.

The relative positions of the different portions of the brain within the human skull are well seen by making a perpendicular section of the skull and brain from before to behind. Fig. 71 represents such a section; and although the student is not supposed to be acquainted with all the ganglia shown in this drawing, it will be found instructive to study it generally, and refer to it again hereafter.

After removing the brain and spinal cord from the skull and vertebral canal, by dividing the nerves as they pass through their appropriate foramina, the student should place the brain upon its upper surface, which will expose what is usually called the *base of the brain* (fig. 72), and the anterior surface of the spinal cord. By the term *spinal cord* we mean all that portion of the cerebro-spinal axis which is contained within the vertebral canal, and which, it will be seen, occupies the whole of the cervical and dorsal regions; but in the sacral and the lower portion of the lumbar, its place in the canal is occupied by the nerves supplying the lower part of the trunk and the inferior extremities. The appearance produced by the collection of the large nerves in the interior of the canal, from its resemblance to a horse's tail, is called the *cauda equina*

(see fig. 81). The size of the cord varies: in the cervical region it is widest, and in the middle of the dorsal narrowest, widening again at the lower part of the dorsal, and then gradually tapering off to a point opposite the second lumbar vertebra, where it appears to terminate in a

Fig. 71.

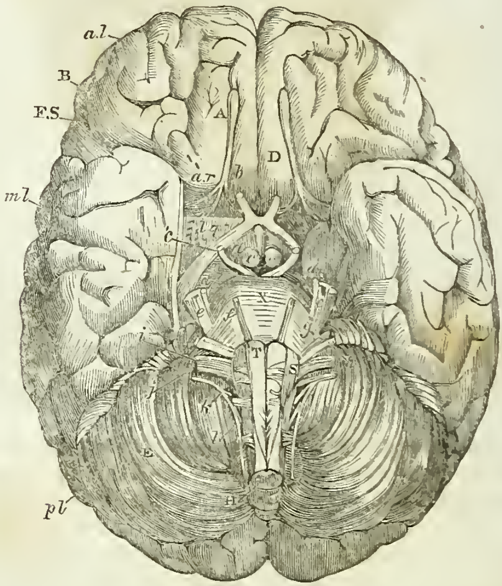
Side view of a mesial section of the human skull, nasal, oral, and laryngeal cavities, the vertebral canal and brain. B. Hemispherical ganglion, or convoluted surface of the brain. E. Cerebellum, showing the arbor vitæ. F M. Falx major of the dura mater. J. This letter is placed on the sphenoid bone, just in front of the sella turcica and pituitary gland. From this body, which is represented as a white rounded knot, there is a white tubular-looking body, extending up to the brain—the infundibulum; this is large. The rounded body behind, is the corpus mammillare. H. Spinal cord. K Thalamus nervi optici; above the letter is the commissura mollis. N. Septum lucidum, which conceals the corpus striatum; the white line behind the letter is the anterior pillar of fornix. P. Corpus callosum. X. Pons Varolii.

single nerve, the ligamentum filiforme, just described. Anatomists have rather differed in opinion as to the exact limits of the cord superiorly: physiologically speaking, it extends to the hemispheres; but guided by its external configuration we may describe its superior boundary as formed by the corpus olivare, with which the medulla oblongata commences. After passing through the foramen magnum into the skull, the spinal cord becomes very much enlarged, and changes its name to that of the *medulla oblongata* (figs. 72, 85). At the upper edge of the medulla oblongata a large knot or thick band of medullary fibres of about an inch in width will be observed passing over and bounding it; this structure is the *commissure of the cerebellum*, or pons Varolii (x). The *cerebellum* (E), or little brain, is the oval-shaped body, to which this structured is attached laterally, and which lies beneath the tentorium when in its normal situation in the skull (see fig. 71).

At the upper edge of the commissure of the cerebellum we observe two rounded bands, about half an inch in thickness, emerging from be-

hind the commissure, and spreading as they pass forwards and outwards to be lost beneath the convolutions of the hemispheres; these are called the *crura cerebri* (*u u*, fig. 72). At the point where the crura are first covered by the convolutions, we observe on either side a thin band of medullary neurine, about three lines in width, crossing them; these two bands gradually approach each other, and, apparently joining, form what is called the *commissure of the optic nerves;* the bands themselves go by the name of the *tractus optici.* The line from *e* crosses this band on the left side. A space is thus left between the divergence of the crura cerebri and the convergence of the tractus optici, of a diamond shape, within which we observe two white rounded bodies, called, from their appearance, the *corpora mammillaria seu albicantia* (*c*), anterior to which bodies, and partly surrounding them, we observe a layer of cineritious neurine, the *tuber cinereum* or *pons Tarini* (*a*), in the centre of which is a funnel-shaped body, the *infundibulum*, or pituitary process, by which it is attached to the pituitary gland (see fig. 71, J).

Fig. 72.



Base of the human brain. A portion of the middle lobe on the left side has been removed to show the tractus opticus and crus cerebri. *a r.* Three roots of olfactory nerve. *b.* Optic nerve. *l q.* Locus quadratus. *c.* Corpora albicantia; the white, funnel-like body in front of these is the infundibulum. *a.* Tuber cinereum. *c.* Third pair of nerves. *d.* Fourth ditto. *e.* Fifth ditto. *f.* Sixth ditto. *g.* Seventh ditto, facial. *h.* Eighth ditto, auditory. *i.* Ninth ditto, glosso-pharyngeal. *j.* Tenth ditto, pneumogastric. *k.* Eleventh ditto, lingual. L. Twelfth ditto, spinal accessory. A. Olfactory ganglion. B. Hemispherical ditto. D. Orbitar convolution. E. Cerebellum. H. Spinal cord. S. Olivary body. T. Pyramidal ditto. *u.* Crus cerebri. X. Pons Varolii. *a l.* Anterior lobe. *m l.* Middle lobe. *p l.* Posterior lobe. F S. Fissura Sylvii.

Behind the corpora mammillaria is a layer of medullary neurine, called the substantia perforata posterior, from its being perforated for the passage of vessels, and posterior to another similar spot; it cannot be seen in this figure. On either side of the diamond-shaped space described,

we observe the mass of convoluted cineritious neurine, denominated the hemispheres of the brain. These are considered as divided into three lobes on each side; the division between the anterior lobe (*a l*) and the middle lobe (*m l*) is well marked by a fissure, called the fissura Sylvii (F S), which corresponds to the lesser wings of the sphenoid bone. This fissure may be traced to the outer surface of the hemispheres, where its depth is considerable. The fissura Sylvii commences near the mesial line, under the tractus opticus, in a broad, quadrilateral, perforated space, to which the student will be frequently directed in the description of the convolutions. This spot is called the *locus perforatus anterior*, or *locus quadrilateralis* (*l q*). The division between the middle and posterior lobe (*p l*) is more arbitrary, and corresponds to the superior angle of the petrous portion of the temporal bone in the interior of the skull.

The description of the arteries, though seen in this view of the brain, will be given after the whole account of the configuration and dissection of the brain is completed.

The different pairs of cerebral nerves may also be seen in this view, but as their exact connections will be minutely described after the student has become accurately acquainted with the real structure of the cerebral mass, it is unnecessary to dwell upon them now.

The dissector may now reverse the position of the brain by placing it upon the base: he will then observe the upper surface of the hemispheres divided by a deep fissure, into which the falx major of the dura mater passes (fig. 71), and by separating the hemispheres he will perceive at the bottom of the fissure a white band of medullary matter, called the great commissure of the cerebrum, or corpus callosum (fig. 77, P).

Let us next direct our attention to the convoluted surface of the brain, which is formed by the folding of the hemispherical ganglion. In the following account I shall follow Leuret and Foville; though I cannot attempt the minuteness of this latter author, who devotes forty pages to his description.

All the convolutions may be said to spring from that spot at the base of the brain which, situated in the fissura Sylvii, is called the *quadrilateral spot*, or *substantia perforata anterior*. This fact is interesting when we revert to the development of the hemispherical ganglion; whether we trace the permanent forms it assumes in the various genera of animals, or in its transient forms during the evolution of the human embryo. At this spot we first observe this ganglion as a mere point; see the brain of the fish (figs. 26, 29, 30, 31) and the brain of the embryo of nine weeks: and from these small beginnings it gradually assumes its enormous size and convoluted form. See also the explanation of the formation of the lateral ventricles (figs. 79 and 80).

In attempting to classify the convolutions of the human brain, it is not pretended that they will be found alike in all brains, but as regards their main form and direction there is considerable uniformity. The variety will be found not so much in the longitudinal foldings, which in the human brain assume a crescentic figure, but in the transverse or anastomosing foldings.

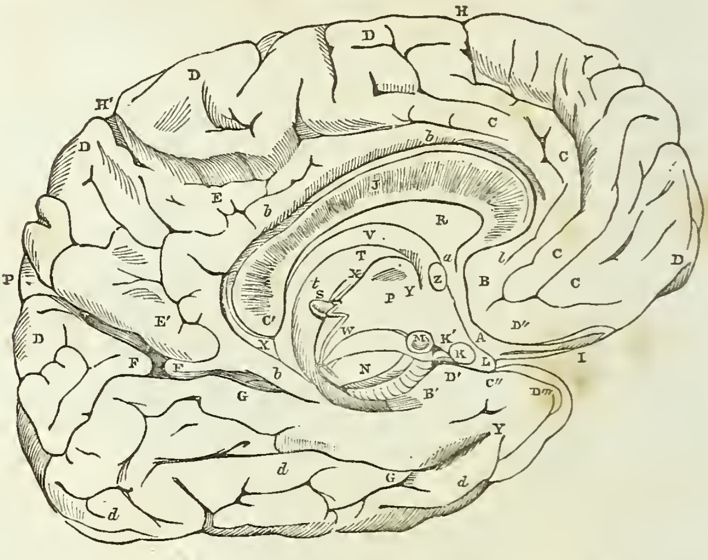
The convolutions are not even exactly alike on both sides of the brain. Curiously enough, we find them almost in exact correspondence in the

brain of the monkey and the idiot, and even in some of the lowest of the negroes.

There are four orders of convolutions. The first order of convolutions contain only one; this is seen in a lateral view of the brain, looking from within outwards, after a section has been made through the mesial (see fig. 72).

It may be described as commencing anteriorly from the substantia perforata anterior, or the *quadrilateral perforated spot—locus perforatus quadrilateralis;* A B the commencement of this convolution, and D′ its termination. It will be seen to spring from the base of the brain at the posterior extremity of the anterior lobe. It then runs upwards and turns (*l*) round the corpus callosum (I), runs (*b b*) along its upper surface, winds down behind its posterior margin, descends to the base of the brain, terminating close to where it began, namely, at the opposite border of the fissura Sylvii, and therefore without crossing it.

Fig. 73.



Internal surface of the left hemisphere of the brain. The great transverse commissure divided in the mesial line. (Foville.) C′ T. Corpus callosum. R. Septum lucidum. V. Anterior pillar of the fornix. Z. Anterior commissure divided. T. Convex surface of the optic thalamus. W. Aquæductus Sylvii. S. Pineal gland. X. Peduncle of pineal gland. N. Section of crus cerebri. M. Corpus mammillare. K′. Tuber cinereum. K. Section of the chiasma of the optic nerves. L. Optic nerve. I. Olfactory nerve. A. Quadrilateral perforated space. *a*. Internal part of the quadrilateral space, where the septum lucidum is united to it. B, *b b b*′, B′, D′. Vertical section of the convolution de l'ourlet (superior longitudinal commissure). B. Beginning of this convolution. D′. Its termination, named the temporal tuberosity. B′. Crotchet of this tuberosity. D″, D D D D D, *d d*, D, D‴. First convolution of the second order, forming the eccentric circumference of the internal surface of the hemisphere, of which the convolution de l'ourlet forms the concentric circumference. D″. The origin of the great convolution of the second order. D‴. Indicates the termination of this convolution in the summit of the temporal lobe. C C C C. Convolutional branches of the third order crossing the internal surface of the hemisphere, uniting the convolution de l'ourlet to the great convolution of the second order. E E. Branch of the third order, uniting the convolution de l'ourlet to the great convolution of the second order in the quadrilateral group. F F. Branch of the third order, forming the peduncle of the triangular group, extending from the convolution de l'ourlet to the great convolution of the second order. G Y. Last branch of the third order, uniting the convolution de l'ourlet to the great convolution of the second order in the cerebello temporal zone of the hemisphere. H. Anfractuosity of the internal surface running up to the eccentric border of the hemisphere. H′. Anfractuosity of the same kind, forming a fissure between the crossing group and the quadrilateral group. P. Fissure posterior to the quadrilateral group.

In following this convolution, the student will find that its course is exactly similar to that which the whole hemispheres take, as will be described in my explanation of the formation of the ventricles of the brain (see figs. 79 and 80, p. 195). This convolution contains within it the superior longitudinal commissure, and marks its direction. It is the hem or *ourlet* of Foville. This convolution he calls *le circonvolution de l'ourlet.*

We have already seen this as one of the primary convolutions of the brain of the fox.

The second order of convolutions comprehends two. They arise, like the last, from the quadrilateral space and also from the last convolution, from which they spring like buds from a branch. The convolution D D D, P, D, *d d*, (fig. 73,) forms the external margin of the circle of the hemisphere, just as the first convolutions form the internal margin of the circle; this is the great convolution. It may be said to run from the fissura Sylvii to the anterior extremity of the hemisphere, and then mounting up, forms the upper part of the hemisphere; and the edge of the median fissure running forwards terminates at the extremity of the temporal lobe (see fig. 74, N, A, D$''$, *l' l*, D G, B G, D G, *q q*, O; fig. 76, *a a a a a'*, D$'$, G G G).

In the brain of new-born infants, and particularly in fœtuses of seven months, this line of convolution is without any sinuosity. In this respect it resembles the simple longitudinal convolutions of the lower animals. Its complexity is occasioned by its enormous length, requiring to be again and again folded transversely to get it into its allotted space (see figures at page 123).

The second convolution of the second order forms the circumference of the fissura Sylvii (see fig. 74, Y, K, I, P P, P, V, E). It presents in its course two divisions, which again subdivide into three. The first forms the anterior lip of the fissure of the external border of the orbitar triangle delineated horizontally; it is moderately winding, and terminates at the junction of the horizontal orbitar region with the convex vertical region of the outer part of the frontal lobe. This convolution we have seen also in the lower animals (see figs. 60 and 64).

This convolution in man, like the last-mentioned, is so long, that in its many transverse foldings we lose sight of its original simplicity.

The convolutions of the third order may be divided into two sets; the first are situated without exception on the internal surface of the hemisphere, and in the internal portion of the fissura Sylvii. They form a sort of anastomosis between the convolutions of the first and second order (fig. 73, C C C, E, F, G, Y, E E, F F). These vary in numbers from five up to eight; Foville says they never exceed nine. These numerous, tooth-like processes from the convolution of the superior longitudinal commissure induced Rolando to call it *processo cristato.* The second set are within the fissura Sylvii, and occupy the space called by Reil *Insula.*

Few of those who dissect the human brain in the old way are aware of the depth, breadth, and riches, if I may so express it, of the fissura Sylvii: they know it only as a slight fissure at the base of the brain, separating the anterior and middle lobes. But those who remove the pia mater from the brain previous to immersing it in alcohol are well

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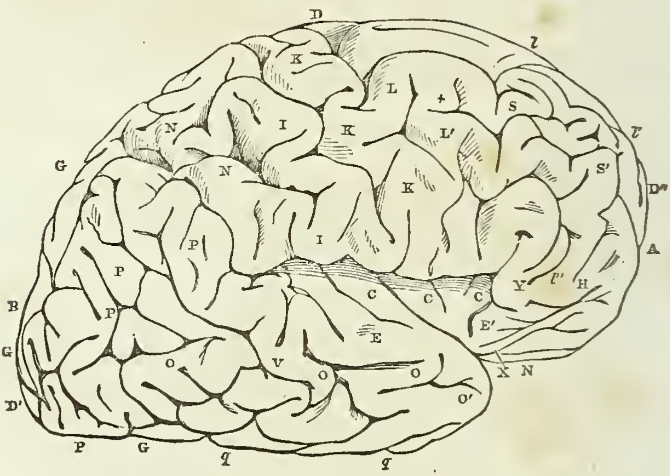
aware that this fissure extends upwards from the base of the brain, on the side of it, nearly to the posterior extremity of the vertex.

The sides of this fissure are not smooth; and as if every chink and cranny should be occupied, to get this enormous convoluted ganglion into the skull, the whole of this fissure is occupied with a distinct set of convolutions. These are pyramidal in form, with their apices towards the fissure, and their bases radiating outwards, as to a circumference of a circle. They may be partly seen in fig. 74 (c c c); but better seen in fig. 75 (c c c c).

Convolutions of the Fourth Order.—The distinctive character of the convolutions of the fourth order is, that they have no direct connection with the convolutions of the first order, that they are employed to fill the space left between the two great lines of the second order.

Fig. 74.

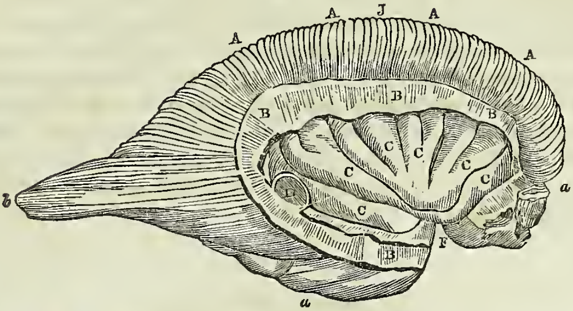


This figure represents the external surface of a cerebral hemisphere. (Foville) This hemisphere is remarkable for the rich development of its convolutions. E'. Y, K, I, P, V, E, indicate the convolution encircling the fissura Sylvii—second convolution of the second order. C, C, C. The convolutionary folds of the insula seen between the lips of this fissure, which are slightly separated. X. N, A. D'', *l' l*. D. G, B, D', P, G, *q q*, O', indicate the great convolution encircling the hemisphere—first convolution of the second order. All the convolutions on the convexity of the hemisphere run from the convolution around the fissura Sylvii to that convolution which encircles the hemisphere. The convolutions which join the second with the first convolution belong to the fourth order. Independently of their connection with the two convolutions of the second order they anastomose sometimes together. Y. *l''*, H. A. Transverse supraciliary convolution running from the anterior angle of the fissura Sylvii to the internal part of the posterior extremity of the hemispheres. I, I. Transverse medio-parietal convolution extending from the second curve of the convolution around the fissure of Sylvius to the twist in the great convolution of the second order, corresponding to the anfractuosity which on the internal surface of the hemisphere separates those crossing from the quadrilateral group. P, P, P, D'. Transverse occipital convolution extending from the sharp angle of the fissure of Sylvius to the posterior extremity of the hemisphere. K, K, K. Anterior transverse parietal convolution situated immediately in front of the transverse medio-parietal. S, S, *l*, *l'*. A branch extending anterior from K, K, K, and anastomosing, *a. l, l'*, with the great convolutionary band—first convolution of the second order. L'. S', *l''*. A branch which, running from K, K, K, anastomose with the transverse supra-ciliary convolution. +, A small branch joining the two abovenamed branches. R, R. Posterior transverse parietal. O, O. O. Short convolutions uniting the extremity of the second convolution of the second order to G, *q q*, O'—the last portion of the great convolution of the second order.

In order to understand these convolutions it is necessary to consider them as prolongations of the convolutions of the third order, below the two convolutions of the second order (see figs. 74 and 76, N N, I I, K K,

L L); and in fig. 76, running directly across the upper surface of the brain (I I), also K, which is more irregular and uncertain than the last.

Fig. 75.



This figure represents the external surface of the cerebrum, the central part of which is covered by the insula. (Foville.) J. Lower part of the fissura Sylvii. C, C, C, C, C, C. Insula. B, B, B, B. Direction of the great layer of converging fibres of the hemisphere. *a*, A, A, *j*, *j*, A, A, *b*. Layer of eccentric fibres of the lateral surface of the cerebrum. *a*. Temporal tuberosity of the convolution de l'ourlet. D. Cut end of a bend in the convolution around the fissure of Sylvius.

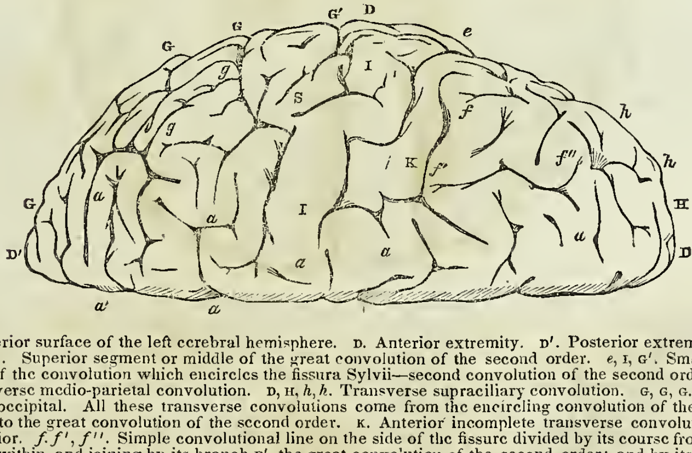
The first region in which these are found is the orbitar triangle, at the base of the brain (see fig. 74, E H).

The second is the great convex space bounded before by the anterior border of the above triangle (see fig. 74, *l''*, H A), and behind by a line extending from the posterior angle of the fissure of Sylvius to the posterior point of the hemisphere (see fig. 74, P, P, P, D').

Lastly, the third region, also slightly convex, extends from this line to the extremity of the temporal lobe (see fig. 74, D', V, O').

This fourth order is especially characteristic of the human brain, from their transverse direction, and their being supplementary to the longitudinal foldings.

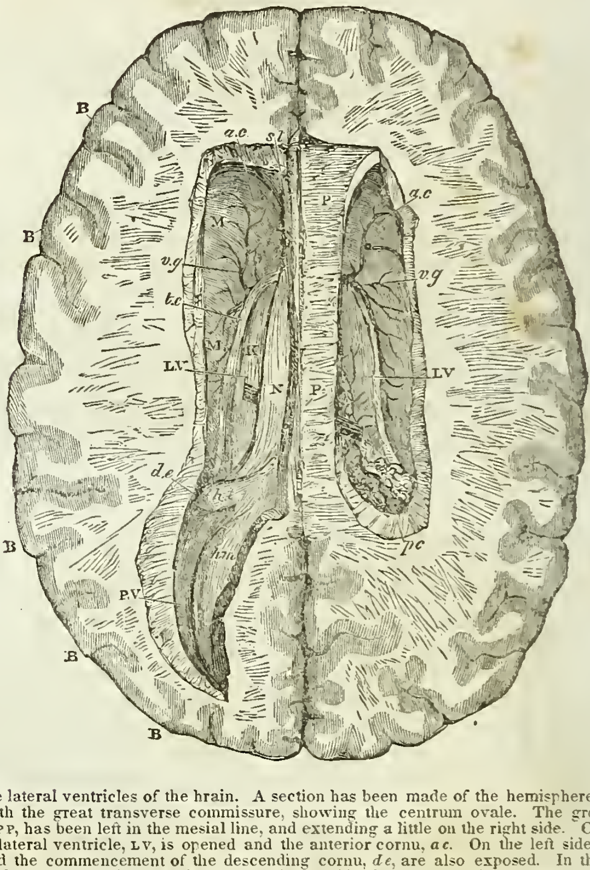
Fig. 76.



Superior surface of the left cerebral hemisphere. D. Anterior extremity. D'. Posterior extremity. D, *a*, *a*, *a'*. Superior segment or middle of the great convolution of the second order. *e*, I, G'. Small fragment of the convolution which encircles the fissura Sylvii—second convolution of the second order. I, I. Transverse medio-parietal convolution. D, H, *h*, *h*. Transverse supraciliary convolution. G, G, G. Transverse occipital. All these transverse convolutions come from the encircling convolution of the fissura Sylvii to the great convolution of the second order. K. Anterior incomplete transverse convolution. S. Posterior. *f*. *f'*, *f''*. Simple convolutional line on the side of the fissure divided by its course from without to within, and joining by its branch F', the great convolution of the second order; and by its branch F'', the transverse supraciliary convolution. *g*, *g*. Line of union of the transverse occipital convolution to the great convolution of the second order. This cerebral hemisphere has been figured as an example of moderate development of the convolutions on the convexity of the brain.—(Foville.)

Figurate Surface of the Brain.—To study this surface, the student should now make a section with a large knife, of one of the hemispheres of the brain, on a level with the corpus callosum, (say the right hemisphere,) cutting from the mesial fissure horizontally outwards: the portion removed must not be thrown away. This section exhibits what is called the *centrum ovale*, and exhibits the disposition of cineritious and medullary neurine in this portion of the brain. The cineritious forms a sort of bark round the white substance; and hence it has been called the cortical substance of the brain (see fig. 77, B B B B). This cortical substance is, in fact, the hemispherical ganglion, the analogue of which the student will remember as a mere rounded point in the fish, in man enormously developed.

Fig. 77.



View of the lateral ventricles of the brain. A section has been made of the hemispheres of the brain on a level with the great transverse commissure, showing the centrum ovale. The great transverse commissure, PP, has been left in the mesial line, and extending a little on the right side. On this side the centre of the lateral ventricle, LV, is opened and the anterior cornu, *ac*. On the left side, the posterior cornu, PV, and the commencement of the descending cornu, *de*, are also exposed. In the body of the lateral ventricle, on the left side, may be seen on the outside the corpus striatum, MM; next to it tænia semicircularis, *tc*, partly covering the veni Galeni, *vg;* next to this is the thalamus nervi optici, K, from the surface of which the plexus choroides has been removed, but still partly covered by the central portion or *body* of the fornix, N. A piece of flat black whalebone runs under the fornix from one ventricle into the other, occupying the natural position of the plexus choroides; on the right side the ventricle is partially covered by the corpus callosum, and the body of the fornix is concealed, but the plexus choroides, *pc*, has been left. The vena Galeni, *vg*, is uncovered by the partial removal of the tænia semicircularis.

In making an examination of the brain for pathological observation, this section is one of great importance, exhibiting clearly the color of this ganglion ; and it is hoped that, for the future, medical men will not omit in their accounts of *post-mortem* appearances, a detail of the condition of this ganglion. It is, indeed, extraordinary, that, in almost all the accounts published in this country, of the condition of the brain in insanity, not one word is said of the general condition or color of this ganglion, though all physiological evidence proves that it is the portion of the brain with which the intellect is immediately connected.

The next step in the dissection is to make a longitudinal incision, as represented on the right side of the mesial line in fig. 77, commencing a little posterior to the anterior edge of the corpus callosum, and extending backwards in a line parallel to the mesial line as far as the posterior edge of this commissure. This great transverse commissure may be seen in fig. 99, partly dissected. This incision must be made carefully, and not extend deeper than a line or two. It will open what appears to be a circumscribed cavity: it is a fissure called the *lateral ventricle* (fig. 77, LV). This space must not, however, be viewed by the student in the light of a cell or cavity, situated in the interior of the brain, the walls of which are formed by the cerebral mass; he must consider it resulting merely from the contact of the different surfaces of the brain. And this fissure is analogous, in fact, to the fissure between the two hemispheres which contains the falx major of the dura mater, or the space between the cerebrum and cerebellum ; the only difference being that the last mentioned spaces are between the external or convoluted surfaces of the brain, instead of between the under part of the great transverse commissure and the upper part of what has been called, in distinction to the convoluted, the figurate or figured surface of the brain.

It is quite true that, in one sense, it is a cavity with walls sufficiently perfect to be capable of containing fluid ; but the important point for the student to understand is, that these walls are not entirely formed by neurine, and that its power of containing fluid arises simply from the mode in which the arachnoid membrane is reflected from the figurate surface on to the convoluted surface. It is in this way that we have a circumscribed cavity, formed from a mere accident in structure, which, in the constitution of the brain, amounts to no more than an irregular but extensive fissure, analogous, in all respects, to the fissures between the different convolutions of the cerebrum. Though it may not, perhaps, be possible for the student, who has only advanced thus far in the dissection of the brain, to have a clear idea of the difference between the figurate and convoluted surfaces, I have considered it advisable to arrest, in the very first instance, any ideas that might arise in his mind as to the ventricles of the brain being perfect cavities, whose walls are wholly formed by the substance of the organ itself. The term *ventricle* alone is sufficient to mislead any one who dissects these parts for the first time.

The figurate surface of the brain is so named, in contradistinction to the convoluted surface, from the projections which compose it presenting regular forms and having received individual names, generally derived

from some trifling peculiarity of appearance, some fancied resemblance to another part, or erroneous views of their functions; nevertheless, however incorrect these titles may really be, it would not be advisable to attempt any sudden and total rejection of them; all we shall do will be to couple with them other appellations which have relation to the structure and function of the part they are used to indicate.

A portion of the figurate surface, and what is usually called the body of the lateral ventricle, having been exposed by the removal of a portion of the transverse commissure, we will consider these parts in order (see figs. 77 and 78).

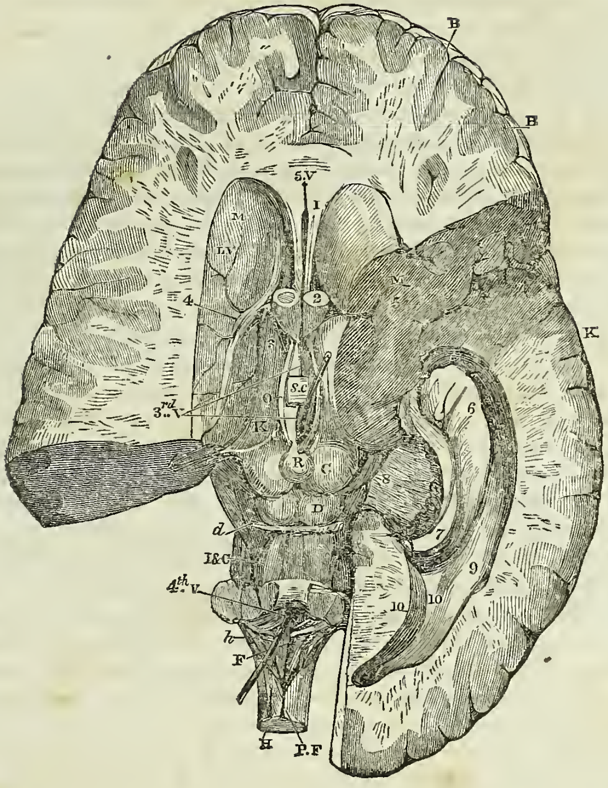
Commencing anteriorly, the first of the component parts of the figurate surface which presents itself to our observation is the *anterior cerebral ganglion*, or *ganglion of the anterior or motor columns*, the *corpus striatum* (M M), whose under surface we have to examine. It is pear-shaped, the base of the pear being forwards and inwards, and the apex or small end lying backwards. Anterior to this ganglion is a deeper portion of the ventricle, the anterior cornu (*a c*): it is separated from its fellow on the opposite side by a portion of the longitudinal commissure called the septum lucidum (*s l*, fig. 77—No. 1, fig. 78). Between the two layers of the septum lucidum is the fifth ventricle (5 V). Posterior to this anterior cerebral or motory ganglion is a vascular membrane, the plexus choroides (*p c*); this membrane, notwithstanding its grand name, is merely the continuation of the pia mater, as will be seen a little further on; if this membrane is raised (see the left side of fig. 77), another large ganglion may be seen (the posterior cerebral), presenting a white surface, and rounded from the thalamus nervi optici (K), through which the posterior or sensory columns pass previously to their expansion in the hemisphere and termination in the hemispherical ganglion (fig. 77, B).

The whole of the thalamus is not yet exposed, the posterior portion being covered by the fornix (see the left side). The thalamus nervi optici is larger in man than in any other animal, and as we have traced it upwards we have found it in many of the higher Mammalia, as in the horse, sheep, &c., assuming a triangular form, at first so narrow that we find it in the mole almost of the form of a scythe. These two ganglia are not so closely united in some of the lower animals as in man: in the cat the separation is very evident, and still more so in the mole.

Between these two ganglia is situated a narrow band of medullary neurine, called, from its appearance, the tænia semicircularis (fig. 77, *t c*, fig. 78, 4); the fibres composing the band are connected with the superior longitudinal commissure, and are considered by Spurzheim as the media connecting the conveying fibres, or fibres of communication, between the two hemispheres and anterior and posterior cerebral ganglia (see fig. 101, *s*). Beneath the tænia semicircularis is a large vein, the vena Galeni, so called after Galen (fig. 77, *v g*; 78, 3). At the posterior extremity of the thalamus, and extending rather beneath this ganglion, are two rounded bodies, which are called the external and internal geniculate bodies; at first sight they appear as if they were a portion of this ganglion, but I believe that they are merely in opposition. They will be better seen in a further stage of the dissection.

Overlapping the internal and posterior part of the posterior cerebral

Fig. 78.



In this drawing may be seen all the ventricles of the brain. The upper part of both hemispheres have been removed with the corpus callosum on a plane a little below that commissure, and the section exhibited in the last drawing. The posterior lobe of the left hemisphere of the cerebrum has also been removed. The cerebellum has been entirely removed, in order to show the posterior surface of the medulla oblongata. On the right side the hemisphere has been cut away still lower, to expose the posterior and descending cornuæ of the lateral ventricle. A piece of bristle is passed from the fourth ventricle through the iter a quarto ad tertium ventriculum. Thus is shown the posterior fissure of the cord, P F, suddenly dilated, 1st, into the fourth ventricle, 4*th* V, or calamus scriptorius; 2dly, into the iter a quarto ad tertium ventriculum; 3dly, into the third ventricle, 3*d* V; and 4thly, into the fifth ventricle, 5 V. In the fourth ventricle may be seen two pyramidal bodies, the auditory ganglia, F; the white lines crossing them are the roots of the auditory nerves. The iter a quarto ad tertium ventriculum is first bounded above by the inter-cerebral commissure, I & C; 2dly, by the optic tubercles, D C, carrying the pineal gland, R. The bristle emerges in the third ventricle, bounded above by the fornix, which is removed, and laterally by the optic thalami, K, on the edges of which may be seen the peduncles of the pineal gland. Anteriorly the third ventricle is bounded by two rounded cords, N N, the anterior pillars of the inferior longitudinal commissure—fornix. In front of these is another narrow chink or fissure, 5, the fifth ventricle. The white lines, which bound this cavity, are the cut edges of that portion of the longitudinal commissure which is called the septum lucidum. On either side of the mesial fissure are the lateral ventricles, 2 2, with their cornua, anterior, A *n*, middle descending, D *e*, and posterior, P *o*. B B. Hemispherical ganglion, or cortical substance of the brain. C. Anterior optic ganglion, nates; D. Posterior ditto, testes—covering the iter a tertio ad quartum ventriculum. F. Auditory ganglion in the fourth ventricle, 4*th* V. H. Spinal cord. K. Thalamus nervi optici, posterior cerebral ganglion. M M. Corpus striatum, anterior cerebral ganglion. O. Pineal commissure. R. Pineal gland. I & C. Inter-cerebral commissure, or processus e cerebello ad testes, covering the iter a tertio. *s c*. Soft commissure, commissura mollis. L V. Lateral ventricles. 3*d* V. Third ventricle; 4*th* V. Fourth ditto; 5 V. Fifth ditto. These three are all dilatations of P F, posterior fissure of the spinal cord. 1. Septum lucidum, a portion of the inferior longitudinal commissure or fornix. This is represented much too thick. 2. Anterior pillars of fornix divided. 3. Vena Galeni. 4. Tænia semicircularis. 5. Corpus striatum divided. 6. Hippocampal lobe, or hippocampus major. 7. Tænia hippocampi, or descending pillar of the fornix. 8. Corpus dentatum. 9. Emminentia collateralis. All these last are situated in the descending cornu of the lateral ventricle. 10. Hippocampus minor in the posterior cornu of the lateral ventricles. *d*. Fourth pair of nerves, pathetic. *h*. Eighth pair, or auditory.

ganglion or thalamus, there is a sharp band of medullary neurine; this structure is a portion of the *inferior longitudinal commissure* or *fornix* (figs. 77, 78, N, 101, E). The connections and precise character of this commissure I shall not describe at present, being anxious to give a connected and uninterrupted view of the figurate surface, merely remarking that the width and extent of the superior portion of the fornix or inferior longitudinal commissure may be observed by dividing the remainder of the transverse about one-third from its posterior edge in the direction of the cerebellum. Before doing this, the student may consider that he has now seen the contents of the body of the lateral ventricle—corpus striatum, vena Galeni, tænia semicircularis, thalamus nervi optici, plexus choroides, and fornix. On removing the rest of the transverse commissure, the fornix will be found to extend on each side nearly an inch from the mesial line, narrowing considerably towards its anterior extremity. It will also be found extending downwards and outwards into a narrow curved chamber, continuous with the lateral ventricle, called the descending cornu (fig. 77, 7). The descending cornu extends first backwards, then outwards, forwards, and inwards, thus forming a curve, the convexity of which is backwards and outwards, the concavity forwards and inwards. As the student is still required to describe, at his examinations, the contents of this cavity, they may be thus enumerated as also six in number (see fig. 78). Their anatomical and physiological relations will be explained with the commissures. The contents of this cornu all take the curve of the cavity, and may be described from within outwards :—A slight projection ; 1st. Emminentia collateralis (9); 2dly. Hippocampus major (6), terminating below in—3dly. A club-like extremity of the body—Pes hippocampi; 4thly. Tænia hippocampi (7), a continuation of the fornix, on raising which, the gray neurine of the convoluted surface at the base of the brain may be seen serrated by the entrance of blood-vessels; 5thly. Fascia dentata (9); 6thly. Plexus choroides, lying over all these. The lateral ventricle also extends backwards, the *posterior cornu* forming a curve, convex outwardly, concave internally ; the projection on its inner wall is called the *Hippocampus minor* (10).

The right side of the longitudinal commissure must next be completely divided, cutting towards the upper surface of the cerebellum, and the divided portions turned to either side, separating them about half an inch. The consequence of this section will, in the first instance, be the further exposure of the pia mater, and a view of the exact point where it quits the *convoluted* to join the *figurate* surface ; the convoluted surface, which the pia mater quits, is the upper surface of the cerebellum. The narrow space left between the under surface of the posterior edge of the inferior longitudinal commissure and the upper surface of the cerebellum, is called the foramen of Bichat, and the pia mater in this situation is known by the name of *velum interpositum*. This membrane, the *velum interpositum*, must now be very carefully raised, and immediately underneath and connected with it will be found a small rounded body about the size of a pea, consisting of cineritious neurine, the pineal gland R, and frequently containing in its interior some gritty matter called the acervulus cerebri ; it forms, together with two white bands,

hitherto known by the title of the *peduncles* (o) of the *pineal gland*, connected to it, a commissure between the optic thalami. The whole structure may be called the *pineal commissure.* Beneath this commissure are situated the *optic tubercles*, which in man, as we have seen in the Mammalia generally, are four in number, instead of being simply binary, as in fishes; these tubercles are usually known by the term *corpora quadrigemina.* The anterior of these are the largest, and are called the *nates* (C), the posterior the *testes* (D).

The geniculate bodies may now be seen more distinctly, the external the smallest, the internal the largest. A band of medullary neurine may be seen running from the testes to the external, and from the nates to the internal. The optic nerves send fibres into their substance, to be described elsewhere (fig. 106).

Fig. 79.

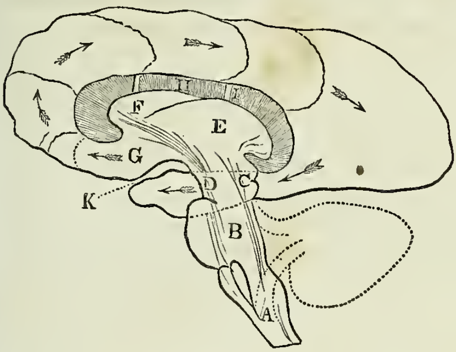


Fig. 80.

Fig. 79.—A. Medulla oblongata. B. Pons Varolii. C. Tubercula quadrigemina. with the fibres of the posterior columns passing in front. D. Crus cerebri, fibres of the anterior columns. E. Thalamus, or posterior striated body. F. Anterior striated body. G. Substance of the hemisphere, springing out from the front of the anterior corpus striatum. H. Space between the striated bodies and the hemispheres caused by the introduction of a small piece of wood. I. The two surfaces, being in contact in the natural state. K. Fissura Sylvii.

Fig. 80—represents the same parts shown by a transverse section through the centre of one side of the brain.

By gently raising the anterior edge of the cerebellum with his knife, (and this must be done with great care, to avoid injuring the fourth pair of nerves (*d*), which lie immediately beneath,) the student will observe, passing from the optic tubercles backwards and downwards to the cerebellum, a broad band of medullary neurine, thick laterally, but extremely thin in the centre; so great is the difference in the texture of these two portions, that the central has been called the Valve of Vieussens; the direction of the component fibres is, however, the same in both. This structure in the aggregate must be regarded as a commissure, connecting the cerebrum and cerebellum, and I have designated it, therefore, the inter-cerebral commissure (I & C, see fig. 78). A more minute description of its fibres will be found under the head of commissures. This view of the figurate surface of the brain will remind the student of the tubercular form of the brain of the fish, to which it bears some resemblance, exhibiting—1st. Corpus striatum, the anterior—the motor ganglion of the spinal cord. 2d. Thalamus nervi optici—the posterior or sensory ganglion of the spinal cord. 3d. The inter-cerebral commis-

sure and cerebellum. The olfactory tubercles which in the fish are exposed, the hemispheres being too small to cover them, are concealed in this view of the human brain, as indeed were the rest, until the hemispheres were divided and turned back. The relation of the hemispheres to the ganglia of the cord, or corpora striata and optic thalami, will be easily understood by referring to the accompanying diagram, where the convoluted surface is represented as commencing at the fissura Sylvii, from which it is traced, first forwards then upwards, then backwards to the posterior extremity, and then forwards again under the striated bodies to the fissura Sylvii.

We may thus compare the corpus striatum and thalamus nervi optici, or anterior and posterior cerebral ganglia, to the head of a stick, to the neck of which, just below the knob, is attached a piece of folded linen (represented by the hemispheres, in the human subject an immense surface), which is first drawn forwards, next turned backwards, and again brought forwards so as to form a complete covering to the head.

PART VI.

DISSECTION OF THE HUMAN BRAIN AND SPINAL CORD.

Spinal Cord, or Medulla Spinalis.—The student should not attempt the dissection of the brain and spinal cord until he has prepared it, by hardening it in alcohol, dilute muriatic and nitric acids, or salt and water. Cruveilhier recommends, instead of hardening the brain by artificial methods, to expose its structure by jets of cold water thrown upon it; though he allows that results obtained by this method confirm those furnished by the study of its structure when hardened by alcohol.*

In conformity with the principles which induced me to preface the study of the cerebro-spinal axis in the human being with a demonstration of the progressive development of the nervous system by tracing it in some of the simplest animals, we shall commence this division of our labors with an account of the configuration and structure of that portion of this system which, protected by the vertebral column, is known by the name of *spinal cord.* Without an accurate knowledge of the component parts of the cord, no one can ever comprehend the intricate structure and mode of composition of the other portion of the system, which, included within the cranium, is therefore entitled the encephalon, or brain.

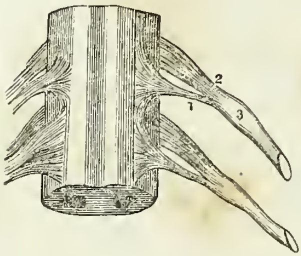
The spinal cord consists of two halves or corresponding portions, placed, as regards the mesial line of the body, laterally to each other, and united anteriorly by a central commissure composed of medullary neurine (fig. 82, No. 1). The fissures separating these two halves of the cord are designated the *anterior* and *posterior fissures* of the *spinal cord.*

The anterior fissure differs from the posterior in being wider, more distinct, and therefore more easily demonstrated, though it is not so deep at the upper part of the spinal cord as the posterior; it deepens, however, as we descend, and is the deeper of the two towards the sacral end of the cord. The pia mater, which closely invests the cord, dips into the anterior fissure, but nevertheless requires to be carefully dissected off before the cleft can be distinctly shown. As the sides of the posterior fissure are in closer contact than those of the anterior, more difficulty is met with in introducing the point of the scalpel into the posterior fissure without injuring the medullary substance. It is curious that so much difference of opinion should have existed among anatomists

* Cruveilhier, t. iv. 560, *op. cit.*, states, that the earliest description of the spinal cord worthy of mention is that of Huber, (J. Huber de medulla spinali: Goëttingœn, 1741), and that it served as the basis of the labors of Haller.

as to the character of these fissures, Haller almost doubting the existence of the anterior one, whilst Chaussier states that it is deeper than the posterior; and Gordon and others, again, stating that in point of depth there is scarcely any difference between them. Connected with the spinal cord, there are thirty-one pairs of nerves, each nerve being in communication with the medulla spinalis by two sets of filaments, which, in the ordinary language of anatomists, are called the *anterior* and *posterior roots* of the *spinal nerves* (see fig. 81). But viewing the connection of these nerves with the cord in strict accordance with the functions which they severally perform, it would be more correct to say that the anterior filaments alone *arise* from the cord, and that the posterior *terminate* there; for the anterior filaments have been proved by Sir Charles Bell and Magendie to be the conductors of the will to the voluntary muscles: they are, in fact, the instruments of volition, the experiments of the physiologists named having proved, that, after the division of the anterior filaments, the limb to which their continuation as nerves is transmitted becomes perfectly paralytic as regards voluntary motion.

Fig. 81.



Section opposite the root of the fifth spinal nerve. 1. Anterior or motor root of the spinal nerves. 2. Posterior or sensory root of the spinal nerves, with its ganglion.

The posterior roots again convey sensation through the medium of the cord to the seat of consciousness, the cerebral hemispheres.

The anterior roots are much smaller than the posterior. The posterior are further distinguished from the anterior in the circumstance of their passing through a distinct ganglion previous to their connection with the cord (see fig. 81). The spinal nerves, however, have been lately proved to be not merely continuous with the constituent fibres of the medullary or fibrous neurine of the cord, but with the gray neurine which is contained in its interior, as will be described a little further on.

Transverse Section.—A transverse section of the cord demonstrates clearly that, with the exception of the anterior and posterior fissures, it it solid throughout. Nevertheless different anatomists have maintained that there was a canal in the interior of it, some not giving it any precise situation, and others, as Portal and Morgagni, describing it as being situated in the middle of the cord, lined by a delicate membrane. Gall and Spurzheim, in their folio work, described two canals running through the whole length of the cord, not communicating with each other, nor with the ventricles, but terminating in a cul-de-sac about the size of an almond in the optic thalami. Spurzheim has since stated* that such canals were produced by the action of the blow-pipe. The canal which exists in the fœtal state is but a dilatation of the posterior fissure, and is gradually diminished by the deposition of neurine; for the pia mater by which it is secreted forms a deep fold posteriorly, the secretion first commencing from the concave internal surface anteriorly, and being continued till this surface becomes level and the whole cord solid.

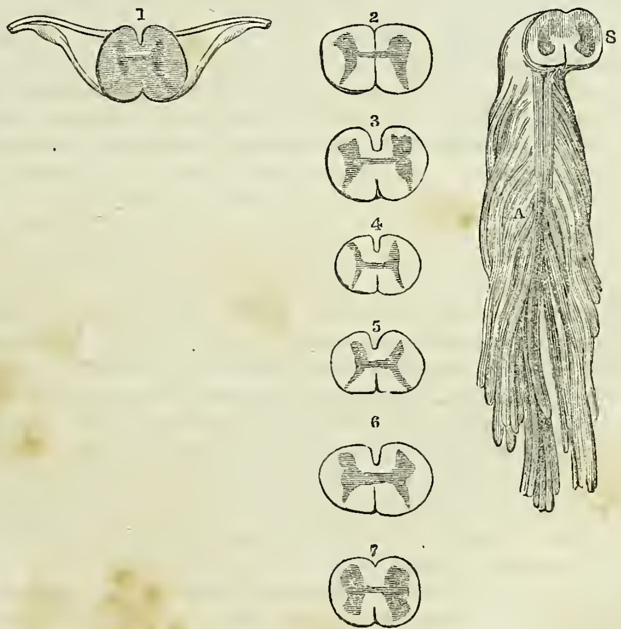
* In the Anatomy of the Brain, 8vo., London, 1820, translated by Dr. Willis.

I am glad to find that, notwithstanding the opinions of Drs. Stilling and Wallach regarding the existence of a canal, and this in the gray substance, my denial of its existence is supported by the observations of Dr. Todd, who says, "I have never, after numberless experiments, been able to see it."—P. 635, op. cit.

The transverse section shows that the cord which externally seems composed alone of fibrous neurine, contains in its interior a considerable deposit of the pulpy matter.

The quantity of gray matter included differs very much in different portions of the cord, as may be seen in fig. 82, Nos. 1, 2, 3, 4, 5, 6, 7, 8; a circumstance which I have before adverted to as throwing some light on the different offices of each kind of neurine. The arrangement of the cineritious neurine is definite and clear, the shape of the included mass, which is best seen by a transverse section, something resembling two C's placed back to back and connected by a narrow line thus,)-(. The anterior horns do not reach the surface of the cord; but the posterior, extending completely through its substance, attain the surface at those points where the posterior roots of the spinal nerves are connected with the cord (see fig. 82, No. 1).

Fig. 82.



Sections of the spinal cord. 1. Opposite the third cervical vertebra, with the anterior and posterior roots of the spinal nerves, and the white transverse commissure. 2. Opposite the fourth ditto. 3. Opposite the seventh ditto. 4. Opposite the fifth dorsal vertebra. 5. Opposite the eighth ditto. 6. Opposite the tenth ditto. 7. Opposite the eleventh ditto. 8. Opposite the first lumbar vertebra. A. Corda equina. This last section exhibits very clearly the great diminution in the quantity of fibrous neurine in this part of the cord, as compared with the cervical region; the bulk of the cord being maintained by the large quantity of vesicular neurine. The diminution in the quantity of fibrous neurine is, of course, the result of its having been gradually distributed by the nerves; each nerve from the first cervical downwards carrying off a few filaments.

This cineritious neurine must be regarded as constituting a chain of ganglia, and not as one continuous ganglion; each set of spinal nerves having its own individual nervous centre corresponding to its osseous centre or vertebra. It is only by thus regarding the composition of the cord that we can account for the uniformity in the number of the cervical vertebræ in Mammalia; the number of the bones being regulated by the number of nervous centres requiring protection. The reason that these are uniform in Mammalia is, that in this class only is there a perfect muscular diaphragm, with a phrenic nerve, having its specific number of roots and corresponding number of ganglia. The anatomical continuity of this gray matter, and its physiological or functional separation into distinct ganglia or centres, is another fact of importance to show that we must not look for anatomical lines of separation in order to establish distinction of function.

If we attempt to divide the medullary neurine of each half of the cord into two portions or columns, the separation may be easily made without the slightest division of its fibrous neurine; and in order to facilitate the description of the ultimate course of the fibres of the cord in that portion, to be spoken of hereafter under the title of *medulla oblongata*, we may consider them as separate parts under the name of *antero-lateral* and *posterior* columns, as these names seem calculated to excite attention to the exact relative position of these two tracts of medullary neurine. The antero-lateral is so much larger than the posterior, that it not merely constitutes almost the whole of the anterior portion, but also the side of the cord. The relative proportion of the antero-lateral and posterior columns varies, however, in different portions of the cord. In the cervical region, for example, the antero-lateral is nearly double the size of the posterior. In the lower part of the dorsal and upper part of the lumbar regions, again, it is not more than one-fourth larger.

By a transverse section of the cord we are also enabled to observe a set of medullary fibres, which, running horizontally across the cord from one side to the other, connect the corresponding halves together. This is the *commissure* of the cord before spoken of, and bears a perfect analogy to the great transverse commissure of the brain. This commissure forms the floor of the anterior median fissure (fig. 82, No. 1).

The student must next become acquainted with the connection of the anterior and posterior roots of the spinal nerves with the gray matter of the cord; but he must not expect to dissect this easily himself, as it can only be discovered when the animal has not been dead more than an hour or two, and we have therefore no chance of exhibiting it in the human subject. Gall was the first to assert that the spinal nerves are connected with the gray matter.

Bellingeri was, I believe, the first who demonstrated the double origin of the spinal nerves from the gray as well as the white matter of the cord.* The reader will find an admirable analysis and review of the contents of his papers in vol. 42 of the Edinburgh Medical and Surgical Journal, from which I have taken the following account: Bellingeri believed that the filaments of the posterior roots of the spinal nerves have

* C. F. Bellingeri de Medulla Spinali, 1823. Experimenta in Nervorum Antagonismum habita a Carolo F. Bellingeri, 1824.

in the human subject at least three different origins, viz.—from the posterior peaks of gray matter, from the posterior lateral fissures, and from the posterior columns of the cord. The anterior roots, he states also, have threefold connection with the antero-lateral columns, but he does not clearly make out their connection with the cineritious neurine.

Notwithstanding this announcement by Bellingeri in 1823, the fact was not established, or generally believed in this country, till 1837, when Mr. Grainger published his interesting and philosophical treatise, entitled, "Observations on the Structure and Functions of the Spinal Cord," in which he distinctly enunciates this important truth. And as I have carefully tested his assertion by several dissections, I feel no hesitation in giving my testimony to the fact that both the anterior and posterior roots are connected with the gray matter of the cord.

Rolando entertains some curious opinions regarding the arrangement of the medullary fibres, describing them as if they constituted an extensive surface folded up; and he gives a drawing of its supposed appearance in a bullock. Cruveilhier considers it to be laminated, but that each lamina is separate from its neighbor—an observation which he remarks is confirmed by pathological analogy.*

Mr. Grainger says—"In considering the interesting phenomena related by Dr. M. Hall, it occurred to me that it might be possible to demonstrate the separate existence of what he has called the incident and reflex fibres; and I was thence induced to dissect, with much care, the two roots of the spinal nerves. After repeated examinations, I satisfied myself that each was connected both with the external fibrous part of the cord, and the internal gray substance. The following is what appears to be the structure:—After the two roots have perforated the theca vertebralis, and so reached the surface of the cord, it is well known that their fibres begin to separate from each other; of these fibres some are lost in the white substance, whilst others entering more deeply into the lateral furrows are found to continue their course, nearly in a right angle with the spinal cord itself, as far as the gray substance in which they are lost. But this arrangement has no resemblance to the distinct division into fasciculi depicted by Mr. Mayo; on the contrary, it is with great care only that small, delicate, and individual threads or striæ, as it were, are traced, dipping into the lateral fissure, and at length joining the gray matter. This difficulty is owing to the fact, that whilst the fibres on the outer surface of the pia mater adhere very intimately with that strong membrane, on its inner surface the neurilemma becomes so extremely delicate that the fibres lose much of their firmness, and break on the application of the least force; an accident which always happens if the pia mater be raised from the surface of the spinal cord beyond the point where the nerves are attached. When the filaments have penetrated into the fissure, they lose their rounded figure and become flattened, and are then seen passing to the gray substance at a right angle to the longitudinal fibres of the cord. It is extremely difficult, owing to the delicacy of the parts, to determine the exact relations which exist between the above filaments and the gray matter; but in a

* IV. 561, op. cit.

few dissections I have been able to see these fibrils running like delicate striæ in the gray substance. In one instance, the fibres being more distinct than usual, an appearance was presented having a remarkable resemblance to that which is seen on making a section of the corpus striatum in a recent brain, after the manner of Spurzheim. My friend and colleague, Mr. Cooper, in this case counted distinctly five separate fibrils passing from the anterior root of the nerve; and there were some other fibres derived from the same root, which were not so plainly seen.

"From numerous examinations I am induced to believe, that whenever the white fibres of the nervous system become connected with the gray substance, whether in the different masses of the brain, in the spinal cord, or in the ganglions, the arrangement is similar to what is seen in the section of the corpus striatum, to which reference has just been made. The fibres become, as it were, incrusted with the gray matter, a disposition which may even be seen by a careful inspection in the convolutions of the cerebrum, in which the radiating fibres of the crus cerebri are observed like delicate striæ. In examining the roots of the nerves, I have always relied on the assistance of the naked eye only, avoiding, for fear of deception, the use of a lens; it also appeared to be preferable to dissect the parts quite in their recent state, so that the natural structure was entirely preserved. The method of Reil, which is so useful in tracing the fibres of the brain, is quite inapplicable in the present case; and Bellingeri has shown that the use of acid renders it very difficult to distinguish the nervous filaments from the blood-vessels.

"The structure above described I had ascertained several months ago, and had, at that time, demonstrated it to several of my friends; but on visiting Germany I found so much skepticism, or rather disbelief, as to the alleged connection with the gray matter, more especially as regards the anterior root, that I very carefully repeated the dissections several times with the aid of an excellent anatomist, Professor Bischoff, of Heidelberg, to whom I am much indebted for the facilities he afforded me of prosecuting the inquiry. In every instance in which the parts were sufficiently favorable for examination, I distinctly traced the connection of both roots with the gray substance; and it is very satisfactory to me to be able to confirm this by the testimony of Professor Bischoff, who although he had shared in the doubts before mentioned, has given me his permission to state that he is convinced, by his own examinations, that the structure above described really exists.

"From careful dissection, I am convinced that it is only a part of the fibres belonging to the two roots which are attached to the gray substance, and that a considerable number of threads are lost in the fibrous part of the cord. The exact mode of their connection, however, with the latter substance is not known."*

The fibres of the spinal cord are very simply arranged, lying parallel to each other, in consequence of which they are easily stripped off, leaving the surface beneath smooth and regular, so that, as Sir Charles Bell observes, "It appears that the superficial layers furnish the roots of the higher nerves, and that the lower layers go off to the roots of the nerves as they successively arise."

* P. 34, op. cit.

The following observations from Dr. Todd are worthy of attention, as coming from such a pains-taking physiologist; at the same time I must again repeat my conviction of the accuracy of Mr. Grainger's account, p. 660. "This question respecting the precise relation of the roots of the nerves to the cord, is one of those in which physiology in a certain sense takes the lead in anatomy. Experiment has made it certain, that while the spinal cord serves as a propagation of nervous power to and from the brain, as in the ordinary sensations and voluntary movements of the trunk and extremities, it is likewise capable of acting as an independent nervous centre, and that movements of a very definite character may be produced in parts connected with it, even after all communication between it and the brain has been cut off. And it has been supposed by one of the zealous laborers in this department of physiology, that a distinct series of nervous fibres is devoted to each class of actions, those, namely, of sensation and volition, and those which are independent of the brain. Mr. Grainger was the first who offered a distinct solution of the anatomical problem which arose out of the hypothesis. Probable as his explanation appears to be, a candid review of the observations which have been hitherto made obliges me to state my opinion, that the question is still *sub judice*, and that further research is necessary to prove unequivocally, that of the fibres composing the roots of the nerves, some pass upwards and enter the brain, and others do not pass beyond the gray matter of the spinal cord; and this inquiry demands more than ordinary care, for the mind of an observer would be easily biased by so attractive a theory as that above referred to."

Dr. Julius Budge, a private teacher of physiology in Bonn, but well known as an industrious contributor to physiological science, has published, in Müller, Archives for 1844, a most important paper regarding this disputed point. With the assistance of Mr. Grainger, I have followed him in his observations, and we both can speak most decidedly as to their accuracy. Fig. 83 is from two drawings made at one time from thin slices of the cord of the frog with the spinal nerve. It strikingly corresponds with those of Dr. Budge, whose figures I had not access to at the time, and I had not seen them for above a twelvemonth, so that my own may be considered as affording independent testimony. Dr. Budge quotes the observations of Drs. Gall, Keuffel, a pupil of Reil, Bellingeri, Rolando, Weber, Valentin, and Stilling, to show that though they had discovered the connection of the roots of the spinal nerves with the gray substance of the cord, they had not demonstrated the continuity of their fibres with those of the columns of the cord up to the brain. Dr. Budge's observations were made on the frog; and while he acknowledges the great difficulty of tracing these fibres, he satisfied himself, by repeated dissections, that the nervous fibres do not run, as Stilling asserts, transversely, but go forwards towards the brain.

He generally took the conus terminalis of the frog's cord, on account of its tenuity. He found a change in the color of the fibres from a bluish gray to a yellowish gray; also in size from $\frac{1}{250}$th of a line to $\frac{1}{700}$th and $\frac{1}{800}$th. These changes are, no doubt, owing to the attenuation of the supporting membrane, as the tubules enter into the composition of the cord, where the presence of the membrane is not required, as in the

nerves. This change in the thickness and strength of the membrane is undoubtedly one great cause of our difficulty in tracing the continuity of these fibres with a dissecting knife. In taking the root of a dorsal nerve, he found it dividing into two fasciculi, one superficial and the other deep. The superficial forms a sort of twisted curve, and then ascends towards the brain. (See figs. 83 and 84.) The deeper plunges into the

Fig. 83.

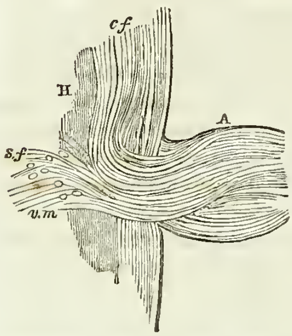


Fig. 84.

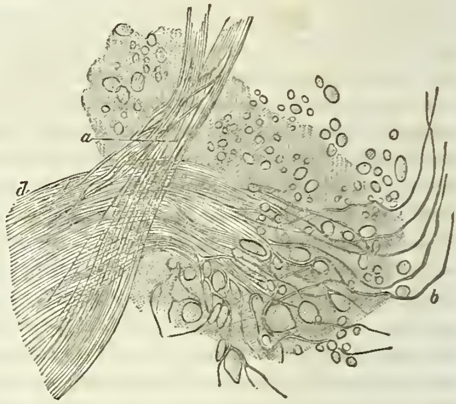


Fig. 83.—Anterior root of the spinal nerve of the frog, showing the twisted arrangement of the fibres at their junction with the cord, and the continuity of fibre towards the brain. A. Spinal nerve. H. Spinal cord. *c f.* Cerebral fibres. *s f.* Spinal ditto. *v m.* Vesicular neurine.

Fig. 84.—Portion of the spinal cord and nerve. (Budge.) Magnified 300 times. *d.* Tenth spinal nerve. *a.* The upper portion, dividing into two fasciculi, cerebral fibres. *b.* The lower fasciculus, curving through the vesicular neurine of the spinal cord, spinal filaments.

gray substance, through which it passes onwards also to the brain; this latter part I doubt, as I believe that these terminate here. It is this twist in the fibres which renders it so difficult to trace their continuity, and hence have arisen the doubts which have been lately thrown out on this subject. If the fibres of volition and sensation could not be traced continuously through the nerves and the cord up to the brain, then are all the discoveries of Sir Charles Bell impotent and inconclusive. But they are not so—Nature never contradicts herself; and I maintain that even if we could not detect it with our dissecting knives and magnifying lenses, the simple pathological fact known to all, that sanguineous effusion into one corpus striatum causes paralysis of the opposite side of the body, is quite sufficient to prove it.

Foville* gives the following account of the connection of the spinal nerves with the spinal cord:—"The lines of insertion of the anterior and posterior nerves that we have pointed out as dividing each half of the spinal marrow into three surfaces, now merit our attention. When we consider them superficially, we could believe that they sprung from a superficial groove, from the bottom of which the roots are detached. This appearance is shown particularly upon the line of the origin of the posterior roots; but with the anterior we quickly perceive that there exists simply a perforation of the superficial layer very fine in this place,

* P. 136, op. cit.

and that the roots traverse this layer to go to another. To demonstrate this fact, we may, after having considered the anterior in their continuity with the substance of the cord, draw them slowly and with caution: we thus distinguish very clearly the nervous layer which traverses these anterior roots. The width of this layer is sufficient to banish any doubt on the subject. The demonstration of a nervous layer traversing, at the same time, a part of the posterior roots, is not so easy. The narrow line from which it appears these roots are detached, particularly in infancy, is very different from the neighboring surfaces: instead of presenting a white color, distinct from the regions which it separates, the posterior line, and the anterior also, but in a less degree, presents in the infant a clear gray color, semi-transparent, across which we see a part of the nervous roots penetrate a certain depth, and contrast their perfect white color with clear gray semi-transparent tint of the matter they traverse; but by looking with attention, aided by the microscope, an extremely fine white layer covering the gray. Besides, in plunging obliquely a stylet into the thickness of this gray substance, and raising it in the direction of the origins of the nerves, the white nervous layer which covers the subjacent gray matter is stretched and torn. This observation seems sufficient to repel the idea of the existence of a furrow from which the roots of the spinal nerves leave." He states distinctly that the posterior roots combine with the white fibrous superficial portions of the posterior columns, which form the posterior limits of their roots, that the other portion of the posterior roots plunge into the gray substance visible on the whole layer of these origins, and the anterior roots, like the posterior, plunge into the spinal marrow, and partly unite with the fibrous substance and partly with the gray. The spinal marrow of the infant is the best for these observations.

Foville, after stating that it is an established principle that all the nerves arising from the same column have analogous functions, in accordance with the fact that there are three fasciculi in the spinal cord from the lumbar region to the brain, arranges the nerves thus:—" 1. Nerves of the posterior fasciculus; 2. Nerves of the anterior fasciculus; 3. Nerves of the middle fasciculus. He divides the nerves of the posterior column into common and special: the common are attached to the posterior fasciculi and common ganglia; the special to the same fasciculi, but also to special ganglia. The special ganglia are the cerebrum and cerebellum; the auditory and trigeminal for the cerebellum; the optic and olfactory for the cerebrum. He describes the spinal accessory as belonging to the lateral column of the cord, and the trigeminal and pathetic to it in the cranium.*

From the statement which has been made regarding the different functions of the anterior and posterior roots of the spinal nerves, the one being destined for motion, the other for sensation, it follows as a necessary consequence that the anterior and posterior fibres of the cord, now the continuity of the fibres of the nerves with their respective columns is proved, must perform corresponding offices; in other words, that the constituent fibres of the anterior and posterior portions of the cord are

* Foville, op. cit., p. 493.

themselves implicated, the one in the production of motion, the other in the conduction of what is called common sensation.

These two portions of the cord are, however, so closely united together that they seem to constitute no more than a single organ, although performing as distinct offices, in reference to the nervous system, as the arteries and veins do in the vascular; the motor columns of the spinal cord, in fact, commencing from the cineritious matter which forms the cortical or exterior portion of the convolutions of the cerebrum and cerebellum, and terminating in the substance of the voluntary muscles, the sensory columns commencing in every texture of the body and extending to the same points from whence the anterior arise, to wit, the cineritious matter of the cerebrum, just as the arteries convey the blood to all parts of the body and the veins return it, the arteries commencing at the heart and ending in the capillary tissues; the veins commencing in the capillary tissues of every organ, and terminating in the heart.

Anatomists used to dispute the question as to whether the spinal cord should be considered as arising from the brain, or the brain be regarded as an enlargement of the spinal cord. Phanagoras, as quoted by Galen,* from the fact of his dissecting the brains of serpents and fishes, regarding the brain as a production of the spinal cord; while later authors, Hippocrates, Vesalius, Willis, Varolius, Haller, Zinn, Sabatier, Winslow, Portal, Chaussier, and Cuvier, have maintained the opposite opinion. On the other hand, we find Tiedemann and Serres maintaining, as the fathers of anatomy did, the same opinion, from a belief that the spinal cord is formed before the brain, which opinion is decidedly refuted by Rolando, who states that the rudiments of the cerebro-spinal system, from its earliest appearance, is always larger at its anterior or cerebral extremity than elsewhere; and that Tiedemann was deceived in consequence of the cord arriving more rapidly at a state of perfection from the greater simplicity of its structure. As a third opinion, I may mention Gall and Spurzheim, who consider that the brain no more arises from the spinal cord than the spinal cord does from the brain; that they are, in fact, several existences. This last opinion appears to me correct as regards the cineritious neurine, but not in reference to the medullary. Indeed, when we consider the different offices performed by the two columns, it is clear, as regards the function of the cord, that the *anterior* columns ought to be described as commencing in the brain, and the *posterior* as terminating there.

Gall and Haller have compared the spinal cord in man with the series of ganglia in insects and in worms, and as it appears to me, with justice; for although Gall may have erred in stating that there are actual enlargements in the spinal cord of the Vertebrata, opposite the origin of the nerves, nevertheless the offices of these centres must be analogous in both divisions of the animal kingdom: and I cannot accord with that usually accurate anatomist, M. Cruveilhier, in regarding them as merely the analogues of the ganglia at the posterior roots of the spinal nerves in man.

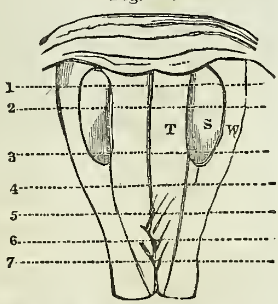
The gray matter in the interior of the cord is quite sufficient in itself

* See Cruveilhier, p. 50.

to establish their identity, and the reason why this gray matter or ganglionic portion is not moulded into knobs or swellings opposite each nerve in the Vertebrata, as it is in the Articulata, is because the same quantity of gray matter thus arranged would offer a greater diameter, and, consequently, require a much wider canal, a more bulky vertebral column, and a larger muscular apparatus to move it. But nature, in this instance, as in every other, concentrates her instruments of power, and husbands her materials.

Cranial Division of the Cerebro-Spinal Axis.—The spinal cord must now be followed into the skull, and its connection with the cerebral mass investigated. In strict accordance with the course of the nervous influence, we ought to describe the voluntary or motory strands from above downwards, and those for sensation, or the sensory, from below upwards. But as this mode of proceeding, even if the exact line of demarkation between them had been ascertained, would greatly increase the difficulties which unavoidably surround every mode of study in this complicated organ, we must not attempt a plan which, however correct in a physiological point of view, would not assist us in our endeavors to obtain correct ideas of its anatomical structure. At the same time it must not be forgotten, that when we speak of the anterior columns as running up to be connected with the cerebrum and cerebellum, our language is not merely metaphorical, but is positively physiologically incorrect.

Fig. 85.

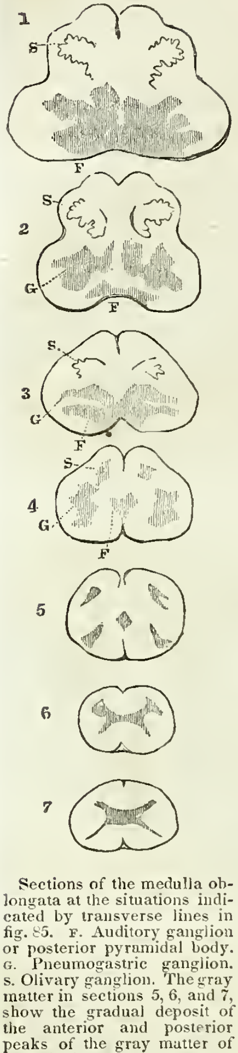


Medulla oblongata. S. Olivary ganglion. T. Pyramidal eminence. W. The restiform body to the outer side of the last-mentioned.

Medulla Oblongata.—The spinal cord, shortly after its entrance into the skull, becomes considerably enlarged, and changes its name to *medulla oblongata* (see fig. 85). This will be found upon section to be entirely altered as regards the arrangement of the cineritious neurine contained in its interior. And here let it be distinctly understood that this enlargement is not occasioned by any swelling of the fibrous or medullary portion, but by the deposit of cineritious neurine in greater quantity than it is met with in the composition of the cord; by the deposition, too, of this constituent of the nervous system in separate and isolated points or masses, a circumstance which does not appear to me to have received the attention which I cannot help thinking it deserves. The view I am inclined to take of the character of the parts comprising the medulla oblongata, is simply this: in addition to the columns for motion and sensation, there are here deposited, and imbedded to a certain extent in its substance, six ganglia, three on each side, anterior, lateral and posterior. The anterior are ovoid bodies, which derive the name of *olivary* (*corpora olivaria*) from their form.

We have seen the *anterior* ganglia in most of the Mammalia, though not always "cropping out on the surface," as the geologist would say. The *lateral* are the ganglia of the pneumogastric nerves (*ganglia restiformia*). We have seen them in the Vertebrata generally, and more

Fig. 86.



Sections of the medulla oblongata at the situations indicated by transverse lines in fig. 85. F. Auditory ganglion or posterior pyramidal body. G. Pneumogastric ganglion. S. Olivary ganglion. The gray matter in sections 5, 6, and 7, show the gradual deposit of the anterior and posterior peaks of the gray matter of the spinal cord.

distinctly separated from the posterior in some of the more bulky Mammalia, where the motor and sensory columns are larger than in man.

The *posterior* ganglia are found in the fissures at the back part of the cord, which is known by the name of the fourth ventricle (see fig. 86). They form two projections of a pyramidal form* (see fig. 78, F). In these terminate the auditory or eighth pair of nerves—posterior pyramidal bodies, or *auditory ganglia.* They have been remarked in the fish under the title of tubercles of the fourth ventricle.†

The arrangement of the cineritious neurine in the olivary bodies will be understood by referring to figs. 86 and 87, where the beautiful contrivance which has been adopted in the arrangement of the cineritious neurine in this ganglion is exhibited. A transverse section (fig. 86) shows the neurine forming a waving line, open internally, but presenting a convexity outwards and forwards; a longitudinal section (fig. 87) still shows a waving line, but the convexity outwards, the concavity inwards. This arrangement is of exactly the same kind as that employed in the hemispherical ganglia, namely, a contrivance by which an extensive surface of neurine is packed into the smallest space. The cineritious neurine of this ganglion appears, indeed, as if it were crumpled up to accommodate it to its confined situation.

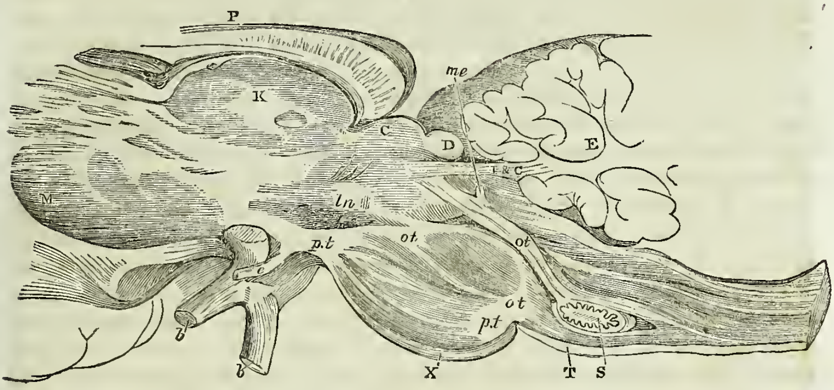
The olivary bodies are not isolated ganglia, but, like the rest of the cerebral ganglia, more or less united; they are connected, by means of some of the longitudinal fibres of the antero-lateral columns, with the cord below and the brain above (fig. 87, *o t*, *o t*, *o t*). These fibres constituting the olivary columns, are on a plane posterior to the posterior division of the pyramidal bodies, which they come in contact with, and then diverge from them again. It has been said that in the crus cerebri these olivary columns appear to divide into two portions, the one passing forwards above the

* Ruysch describes the restiform bodies under the name of posterior pyramidal: and Rolando describes the internal lamina of the restiform bodies by that name, and even warns the reader against confounding them with the restiform bodies.

† Foville says, "The restiform body is incontestably a prolongation of the posterior fasciculus of the spinal cord. The olivary body, and small filaments in the interval of which it is situated, are evidently continuous with the antero lateral columns of the spinal cord."—P. 312. "The olivary eminences are but a part of the lateral fasciculus, containing in their interior a double festoon of yellow substance. The superincumbent white layers which compose the exterior of the olivary bodies may be easily traced to the superior parts of the lateral fasciculus." This author does not propound any theory of the probable office of this ganglion.

locus niger, the other ascending to the tubercula quadrigemina and thalami nervi optici; but this description is not physiologically correct. The greater part of the olivary column, for reasons stated further on, must be considered a part of the motor tract.

Fig. 87.



The special object of this drawing is to show the relative course of the pyramidal and olivary portions of the motor tract through the pons Varolii and crus cerebri, as exhibited by a longitudinal section. It also shows a most important point in the anatomy of the medulla oblongata,—namely, the connection of the motor root of the fifth nerve, *m e*, with the olivary tract. C. Anterior optic tubercle. D. Posterior ditto. E. Cerebellum. K. Optic thalamus. M. Corpus striatum. P. Corpus callosum. S. Olivary body. T. Pyramidal ditto. X. Pons Varolii. I & C. Inter-cerebral commissure, or processus è cerebello ad testes. *b b*. Optic nerves. *e*. Third pair. *l n*. Locus niger. *m e*. Motor root of the fifth pair. *o t, o t, o t*. Olivary tract, one portion running up to the optic tubercles; another running through the pons Varolii. *p t, p t*. Pyramidal tract running through the pons Varolii, the continuation of which through the corpus striatum is marked *m t*.

The true olivary columns are placed to the outer side of the sensory tract.*

These olivary columns connect together the origins of the third, fourth, and fifth pair, the auditory nerves, pneumogastric, glosso-pharyngeal, and lingual nerves. These extensive commissural connections of the olivary ganglia render my supposition regarding their office still more probable. If it is their office to preside over the movements of the tongue as an organ of speech, we can quite understand the necessity of its being closely connected with all the ganglia of special sensation.

Dr. Todd considers "that the olivary columns constitute the fundamental part of the medulla oblongata, that on which its action as a distinct centre depends."

Gall described this fasciculus of fibres ascending from the olivary bodies through the pons Varolii. Rolando† distinctly denies that any such fibres are to be met with; at the same time he suggests that the fibres so described are most probably "the anterior cords of the medulla spinalis, which are compressed, as it were, between the peduncles of the cerebellum and olivary bodies."

In the sheep, the horse, the calf, and the cat, I find (see figs. 52 and 56) that there is a wavy line of gray matter in the very centre of the

* 1847. I have again and again dissected these parts, and I am quite convinced of the accuracy of my description, though in opposition to some high authorities.

† Saggio sopra la Vera Struttura del Cervello, 2d edit., vol. i. p. 53. Toreno, 1828.

corpus pyramidale, which is clearly the analogue of the corpus olivare in man. In the porpoise, as already mentioned, this deposit of gray matter holds the same situation, only that it forms a projection on the surface, which it does not in the horse and calf. In the horse it is some distance from the pons Varolii, and much nearer the origin of the lingual nerve than the pneumogastric.* The difference of its position in the human subject I conceive simply arises from the difference in its size, which in man is so great that it is pushed upwards to the surface.

Dr. John Reid,* in an interesting paper, entitled, "On some points in the Anatomy of the Medulla Oblongata," was, I believe, the first to point out that "the olivary is a motor column." I have carefully investigated this point since my first edition : I fully agree with him ; also in the important fact that the motor root of the fifth pair arises from it, which I made out, without being aware that he had previously discovered the same. The origin of the motor or non-ganglionic root of the fifth pair of nerves has long puzzled anatomists, and we find a different description in most anatomical works. One of the latest and more carefully detailed is by Dr. B. Alcock, of Dublin, in the Encyclopædia of Anatomy; it is too long to extract as a whole. He traces both roots down to the medulla oblongata, saying that "having traversed the crus cerebelli, they are both attached below and behind it to the same part as the greater packet (the sensory division) and posterior to it." He states that there is a slight eminence at the point of junction of the two roots, from which two cords descend, "one for each column of the spinal marrow," one portion into the posterior column, the other into the anterior. Now it appears to me that Dr. Alcock has traced the olivary column down as the motor root of the nerve. At the same time it should be understood that the above short account does not do justice to the very full and minute description which Dr. Alcock has given, and which the anatomist should peruse for himself. In fig. 87, the reader will see the connection of the motor root of the fifth, as easiest displayed by dissection.

The *ganglia restiformia*, or the ganglia of the pneumogastric nerves, which form such a prominence in the skates and some other fishes, do not form any projection on the surface of the medulla oblongata of the human subject. They are covered by the fibres of the corpora restiformia; their relative situation, and the anatomical line of demarkation between them and the auditory ganglia, may be seen distinctly in a transverse section of the medulla oblongata at this part (fig. 86).

The ganglion restiforme (G) I have little doubt is an important organ in the function of respiration, for the pneumogastric nerve, which both terminates in it and arises from it, like the spinal nerves, is a compound nerve; it is a nerve of sensation in relation to the sensibility of the lining membrane of the respiratory organs,—the "besoin de respirer" is dependent upon it; it is also a nerve of motion, in as much as the muscles of the larynx and the muscular tissue of the trachea, bronchi, and stomach, are under its control. So far, then, the opinion of Mayo, referred to further on, that nerves of sensation and motion supplying the

* Edinburgh Medical and Surgical Journal, January, 1846, vol. lv. p. 15.

same parts are connected with one deposit of cineritious neurine at their central extremity, is confirmed in this instance. It is therefore highly probable that the gray matter at the posterior part of the cord (G) is a central point, from whence emanates that peculiar power which the system of respiratory nerves conducts, and by which they call the respiratory muscles into action independently of volition. In support of the opinion that the respiratory muscles are dependent on this portion of the medulla oblongata for their stimulus to contraction, the results of two or three experiments may be related.

A section of the spinal cord made above the origin of the intercostal nerves simply annihilates, as regards the respiratory movement, the power of the intercostal muscles. A section above the phrenic nerve induces paralysis of the diaphragm also; while a section exactly at the origin of the par vagum, and therefore through the medulla, occasions a total cessation of every respiratory movement, and instant death. If the section, however, be made above this point, then the whole of the respiratory movements take place as usual. Is it not, then, from this point, and this only, that they draw their power of motion? A section of the par vagum produces no such immediate effect; the section must destroy the restiform ganglion before total interruption to the respiratory action can take place.

For the proofs that the sensibility of the air-passages is dependent on their connection with the encephalon through the intervention of the par vagum, I must refer my readers to Brachet's* researches on this interesting subject.

The relation of the antero-lateral and posterior columns of the spinal cord to these ganglia of the medulla oblongata, must next be studied, as this will be the clearest method we can adopt for arriving at a knowledge of their connection with the cerebral mass.

For this purpose let the pia mater be carefully dissected off from the surface of one-half of the spinal cord, and, in so doing, all the nerves on one side may be removed; those on the opposite, however, being sedulously avoided. In removing this membrane, where dipping into the anterior fissure, as described in the directions for dissecting the cord, the student will find, about an inch and a half from the pons Varolii, several medullary bands crossing the anterior median fissure obliquely from one side of the cord to the other; these bands belong to the anterior columns: and this crossing of their fibres from one side to the other is technically called the *decussation* of the *pyramidal bodies* (see fig. 85).

This fact of the decussation of the anterior columns or motory tract of the spinal cord is extremely important, and particularly interesting in a pathological point of view, explaining, as it does, the fact, that disease of the right side of the brain almost uniformly produces paralysis of the left side of the body, and *vice versâ.* Hippocrates himself mentions the fact, that lesions on one side of the head were often observed to occasion palsy on the opposite side of the body; but Aretæus was the first who attempted to explain it, by supposing a decussation of the nerves at their origin in the brain. Dion Cassius is the next who speaks of a

* Récherches Expérimentales sur les Fonctions du Système Nerveux Ganglionaire, par J. L. Brachet, 1834, p. 135.

decussation of the cerebral nerves and spinal cord; but with him the subject dropped, and the attention of the medical world was only recalled to the fact in 1581, by Fabricius Hildanus. The true decussation of the pyramidal bodies, however, was first described by Mistichelli, in 1709; it was noticed by Petit in the year following, and at a later period by Lieutaud, Santorini, and Winslow. The same authors also speak of other decussations, but probably on mere supposition.

"Modern anatomists," says Dr. Spurzheim, "before Dr. Gall and myself, were divided in opinion upon the subject of decussation. Many admitted the fact, but no one pointed out the place of its existence. Vicq d'Azyr, for example, confounds the simple transverse fibres between the two halves of the spinal cord with the true decussation of the pyramidal bodies. Many others, among the number Prochaska, Barthez, Sabatier, Boyer, Dumas, Bichat and Chaussier, have, in the most positive terms, denied the decussation of the pyramidal bundles altogether, as we have shown in our reply to the Report of the Committee of the French Institute upon our Anatomical Memoir."*

Rolando entertains some curious ideas on the subject of the pyramidal bodies; for he states, page 60 of the work referred to, that "the pyramidal bodies must not be considered as a division of the principal cords of the spinal marrow, since these fasciculi of medullary fibres are not in any way continuous with the fibres of the medulla, which it is easy to see. The fibrous fasciculi, and the roots, so to speak, of the pyramids, begin on the anterior face of the medulla spinalis fourteen or sixteen lines below the annular protuberance, and the anterior columns run behind them. It seems that Tiedemann has been led to admit the continuation of the pyramids with the anterior columns, from the decussation observed at this point: however, the fact that the fibres of the pyramids only have their *origin* from that point at which the crossing is perceptible, forms a strong argument against the received disposition; since it is very evident that if they only arise from this point, they cannot pass to the opposite, or be continuous with the fibres of the spinal marrow." In addition to which, Rolando states that his observations on the chick confirm his opinion that the pyramidal bodies are merely placed upon the spinal marrow.

Burdach† describes the pyramidal bodies as consisting of *fundamental* and *decussating* fibres; the fundamental fibres he derives from the *floor* of the anterior median fissure: in this particular he appears to me in error, and for this simple reason—the floor of the median fissure, as I have already stated, is formed by transverse commissural fibres, and the superior edge of this commissure of the cord is distinct immediately below the point of decussation, but without any fibres to be seen ascending from it.

Burdach, however, is perfectly right in describing certain fibres of the anterior columns, which form the edge of the anterior median fissure, and enter into the composition of the pyramidal bodies, as continuing the course along the same side of that fissure without crossing it.‡

* See Spurzheim's Anatomy, p. 147.

† Vom Baue und Leben des Gehirns. Leipsic, 1822, vol. ii. p. 31.

‡ Cruveilhier, who admits the decussation of the pyramidal bodies, nevertheless denies

The *decussating* fibres of the pyramidal bodies are derived from the antero-lateral columns behind the anterior roots of the spinal nerves, and in front of the posterior peaks of gray matter. Ascending from this position in the cord towards the mesial line to decussate with their fellows on the opposite side, they pass to the inner side of the main portion of the anterior columns, which here retreat from the mesial line to make way for them. The lateral columns, then, in passing from the posterior and outer side of the cord towards the inner, are overlaid by certain fibres of the anterior columns. Some of these fibres of the anterior columns ascend like those of the pyramidal bodies through the pons Varolii to the cerebrum; but encountering the olivary bodies in their way, they are split by them, and, forming an envelop for them, have been called by Burdach, Hüllenstrange, or envelop, or shell cords. Other fibres from the anterior columns, which will be more minutely described elsewhere, run up to the cerebellum.

There are, it is true, a few cases on record, in which no decussation of the pyramidal bodies has been discovered; but such cases must be viewed as exceptions to a general rule. Let the student, then, distinctly understand, that the pyramidal figure, which appears drawn, as it were, on the anterior surface of the cord, and gives rise to the term corpus pyramidale, is simply caused by the crossing over of the constituent fibres of the antero-lateral columns from one side to the other; that it is not occasioned, as is the projection of the corpus olivare, by the addition of fresh masses of either cineritious or medullary neurine, as supposed by Rolando. Though the term pyramidal body is objectionable, as implying the existence of an independent or distinct structure, nevertheless, as the term has been so long sanctioned, we must continue to employ it, at the same time considering it merely an appearance necessarily produced by the oblique overlaying of certain constituent fibres of the cord.

The decussating fibres of the spinal cord are therefore not merely the fibres of the anterior columns, but also those of the lateral columns: the posterior surface of these decussating fibres may be seen from behind by separating the sides of the posterior median fissure; and I cannot help thinking that it must have been this view of the decussation of the pyramidal bodies which Sir Charles Bell mistook for a true decussation of the posterior columns. For I have looked frequently, but in vain, for any such decussation of the posterior columns.

A view of the section of the cord at this point will, I think, be found very interesting, as showing the relation of the decussating fibres to the gray matter (see Nos. 5 and 6, figs. 85 and 86).

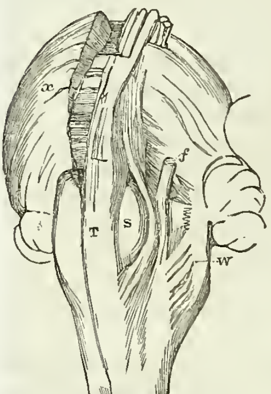
Line of Demarkation between the Tracts of Sensation and Motion.—Although the different offices performed by the anterior and posterior roots of the spinal nerves have been, I think, clearly ascertained, and as it is also evident that the spinal cord consists of tracts of neurine whose office is the same as the nerves which are connected with them, and therefore that there are portions of the cord which perform functions as distinct from each other as the arteries and veins, still anatomists are not yet agreed as to the line of demarkation between them. Sir Charles Bell,

that they are continuous with the anterior columns. P. 594, t. iv., he says, "Que les pyramides antérieures ne sont en aucune façons continués aux cordons antérieures de la Moelle."

for instance, in a paper published in the 135th vol. of the Philosophical Transactions, states that he regards the lateral portion of the antero-lateral columns as a part of the tract for sensation, and I have no doubt of its correctness. The circumstance of there being no decided anatomical line of division between the two columns, is not of itself an argument against the correctness of this view; for it is quite possible that perfect distinctness of parts, as regards their function, without any visible line of separation between them, may exist. We must always bear in mind that the neurine which composes the cord, is supported and clothed by a perfect though delicate membrane, which, pervading its substance in every direction, is undoubtedly as capable of separating masses of neurine endowed with distinct powers, and ordained by nature to execute distinct offices from each other, as any fissure, however wide, or membrane, however thick. The presence of such gross and palpable partitions, it is true, would save us some trouble in discovering the line of demarkation, but would not necessarily make it in any way more efficient. They are not the less distinct organs because of our ignorance of their respective limits, any more than a nerve of motion is one of sensation because we are incapable of unraveling the fibres of each from their common investing membrane.

That the boundary line between the two organs of sensation and voluntary motion comprised within the spinal cord cannot be formed by the posterior peak of gray matter, is very decidedly proved by the fact that a portion of the fifth pair of nerves, which we know to be a nerve of sensation from the beautiful experiments of Mayo and Sir Charles Bell, is not connected with the posterior, but with the lateral columns. This is seen in fig. 94.

Fig. 88.



This drawing exhibits an unusual, but instructive, separation of the fibres of the pyramidal body by the olivary body, and their juxtaposition again in the pons Varolii. S. Olivary body. T. Pyramidal body. W. Restiform body, some of the cerebellar fibres of the anterior columns seen on the surface. X. Pons Varolii. *f*. Glosso-pharyngeal nerve turned out of its natural course.

Some have supposed that the olivary bodies divide the motor from the sensory columns; but we have seen in the medulla of the horse, &c., that the position of the above ganglion varies, and is accidental: in some actually imbedded in the pyramidal tracts. In the human subject we often find the fibres of the anterior columns diverging at these bodies, and meeting below them, as will be seen in fig. 88.

The antero-lateral columns within the spinal canal consist of fibres, which simply lie parallel to each other without interlacing like the filaments of a nerve; so that if a portion of the cord (previously hardened in alcohol) be taken in the forceps, it splits up without any difficulty, and the fibres themselves do not appear to be torn, but merely the membrane connecting them. If this mode of proceeding, however, be attempted on the medulla oblongata, we find, that the fibres,

no longer maintaining an even parallel course, easily break off; and great care, therefore, is required to trace them to their destination, for some begin to take one course and some another.

Before attempting to dissect them, the student had better digest the following outline of their course and destination. Each lateral half of the spinal cord consists of a posterior column and an antero-lateral column. The antero-lateral column is divisible, physiologically, into two portions, the anterior half of the cord or two-thirds of the antero-lateral column forming the motor tract, the posterior third of the antero-lateral column being half of the sensory tract.

The anterior or motor tract is anatomically further divisible, viz., into two columns, the pyramidal and olivary. Both of these give fibres to the cerebrum and cerebellum.

Besides these fibres of the antero-lateral columns, which may be described under the title of cerebral and cerebellar fibres of the anterior or motory columns, there is another set which, in the spinal cord, occupies a completely lateral position, being separated from the posterior columns by the posterior peaks of gray matter. These were regarded by Sir Charles Bell as the *cerebral* strands of *sensation;* cerebral, because, as will be explained a little further on, they terminate in the cerebrum; of *sensation*, because the posterior roots of the spinal nerves are connected with them.

All the fibres of the posterior columns, or those columns which are separated from the rest of the cord by the posterior peaks of cineritious neurine and the groove of the posterior roots of the spinal nerves, take their course directly to the cerebellum; none of them whatever can be traced to the cerebrum. Both these portions of the sensory tract will be traced to the cerebrum after the description of the course of the anterior columns is concluded.

Let us first follow the fibres of the spinal cord which go to the cerebellum. Of the fibres which run from the antero-lateral columns to the cerebellum, there are evidently two sets, one superficial and one deep.

The *superficial*, which may again be divided into two sets, are derived from the pyramidal columns, the *deep* from the olivary columns. The former cross the surface of the cord immediately below the corpus olivare, and may generally be seen without dissection; they are more distinct in the sheep, bullock, and horse, than in man, in whom they form a very thin layer emanating from the corpora pyramidalia, and I have no doubt that they actually decussate with their fellows of the opposite side, forming in fact part of the apparatus of decussation, though I have not yet positively ascertained the fact.

The *second* of the superficial set of fibres take the same direction: only, instead of crossing the cord immediately below the corpus olivare, they run to the inner side of the corpus olivare, and then ascending to the cerebellum, they form the outer part of the corpus restiforme.

The *deep* set of fibres from the antero-lateral columns to the cerebellum, are the most posterior of the whole mass of fibres composing this portion of the spinal cord. They are separated from the posterior columns by the posterior fissure, from which the posterior roots of the

spinal nerves emerge; this fissure they cross in their passage to the cerebellum, obliterating it entirely.

Fig. 89.

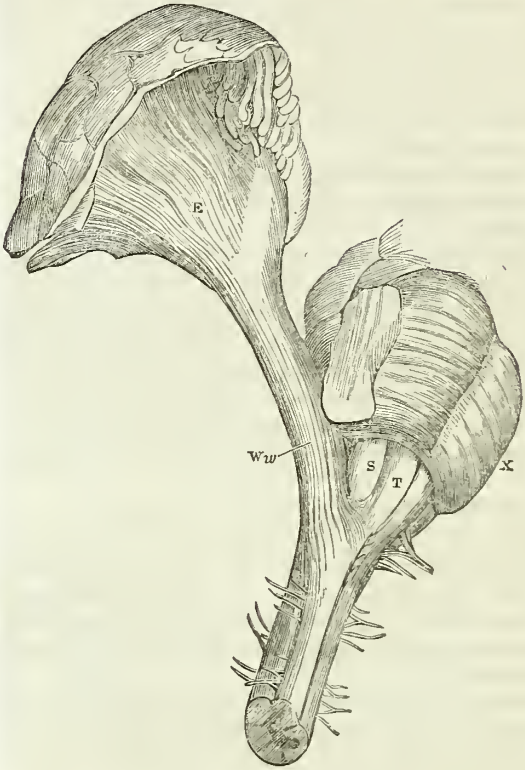


Fig. 90.

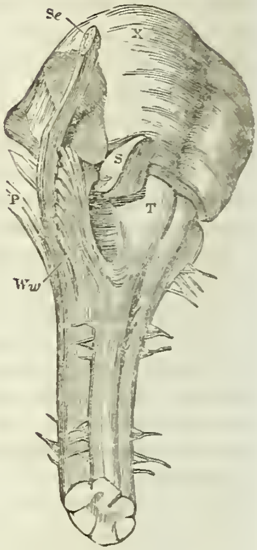


Fig. 89.—This figure exhibits those fibres from the anterior columns which, ascending to the cerebellum, connect the motor tract with that portion of the cerebral mass. E. Cerebellum. X. Pons Varolii. T. Pyramidal eminences. S. Olivary bodies. W *w*. Corpus restiforme, its surface having been carefully scraped, in order to show the *superficial cerebellar fibres* of the anterior columns. They are represented rather more distinct and thick than they really appear, though their course, direction, and relation to the olivary body, are faithfully given.

Fig. 90 displays a deeper view of the same fibres, and the connection of the sensory root of the fifth pair of nerves with the lateral portions of the spinal cord, and the passage of this root behind the cerebellar fibres of the anterior columns, W *w*. The corpus olivare having been raised, those fibres which run behind that body are exposed. The figures are the same as the last, with the exception of S *e*, designating the sensory root of the fifth pair of nerves, and P, which designates the fibres from the posterior column forming part of the restiform bodies, or processus è cerebello ad medullam oblongatam.

Thus it will be perceived that one portion of the antero-lateral columns—for there is yet another portion of these columns to be described—on reaching to within a small distance of the corpus olivare, splits into three sets of fibres: one, the most anterior, which passes through the pons Varolii, as will be described presently, may be designated the *cerebral* fibres of the anterior columns; a second set, which may be entitled the *superficial cerebellar* fibres of the anterior columns, passing over the surface of the medulla oblongata, are usually seen without dissection.

Rolando* describes the superficial cerebellar fibres of the anterior columns, those which are seen without dissection, (the processus arciformes of Santorini,) under the name of "filamenti arciformi," saying, "I believe that I ought to give such a name to numerous filaments which are seen to issue from the transverse fibres of the annular protuberance precisely at the same spot where the anterior cords penetrate into its centre. The filamenti arciformi nevertheless descend and partly cover the above-mentioned cords, expanding on the corpora olivaria, and extending even to the median fissure, by which they remain separated from each other. Such a disposition is constantly observable in quadrupeds, in which the said filaments are extremely distinct, although no mention has hitherto been made of them." Rolando does not, however, trace them, as he might have done, to the cerebellum instead of describing them as descending from the pons Varolii.

The third or *deep cerebellar* fibres of the antero-lateral columns, proceeding in company with those of the posterior columns, form about a fourth part of the whole diameter of the restiform bodies.

From the above description it will be remarked that the anterior columns of the cord, which have hitherto been spoken of as simply passing up through the pons Varolii or commissure of the cerebellum, to be connected with the cerebrum,† are described as passing also to the cerebellum. In a paper which was read before the Royal Society in May 1836, and published in their Transactions, part 2d, for 1836, I proved that they were connected with the cerebellum as well as with the cerebrum, as allowed by Mr. Mayo and Mr. Owen, to whom my preparations were referred. Since that time I have had the opportunity of showing the same preparations to many of the first anatomical teachers in England, who consider the point fully established. They are now deposited in the Museum of the College of Surgeons. The corpora restiformia, or the processus è cerebello ad medullam oblongatam, are not therefore, as they have usually been described, bodies which are formed solely by the *posterior* columns: nor are they bodies which consist of fibres from the posterior columns, to which some fibres from the anterior columns are added, the additional fibres lying perfectly parallel to those of the posterior columns; but they are bodies which consist of fibres that interlace in rather an intricate manner, the interlacing fibres consisting of some from the antero-lateral and some from the posterior columns.

It is rather curious that Rolando should have approached so nearly to the discovery of the fibres above described, as connecting the anterior

* Op. cit., vol. i. p. 147.

† Meckel speaks of the anterior columns, as dividing into two halves, an anterior and posterior; these he describes as running up to the inner side of the corpora olivaria, on a plane with the fourth ventricle. Besides which, he states that a smaller fasciculus, which Gall describes as being occasionally absent, after touching the above bodies, ascends to the corpora quadrigemina. Mr. Mayo is almost the only author who points out the fact, that the restiform bodies are not alone formed by the posterior columns, though the exact course of the additional fibres he was not aware of, for he describes the superficial fibres spoken of above, as descending instead of ascending. In his second edition of his Outlines of Physiology, p. 273, he says, "On cutting through and stripping down the corpus restiforme, it is found to carry with it the posterior lateral furrow; the anterior lateral furrow terminates among fasciculi which are continuous with the corpus olivare." The observations he omitted in his 3d edition.

columns with the cerebellum, and yet have just fallen short of understanding them, as is even more evident by the further perusal of other passages in his writings; for at p. 142 he remarks: "All anatomists agree in saying that the posterior surface of the olivary body is in contact with the superior surface of the peduncles of the cerebellum. Malacarne observes, however, that they are separated from them by means of a medullary layer of the shape of a half-moon. To my thinking, this question has been too superficially examined. No anatomists who have especially studied the brain have detected that between the said olivary bodies and the inferior peduncles of the cerebellum are placed fasciculi of medullary fibres which are *continuations of the anterior cords* of the medulla spinalis. This omission appears to me to have arisen from their not having paid sufficient attention to the direction of the fibres and filaments of which these are composed. If the anterior cords of the medulla spinalis be carefully examined a little below the pyramids, we see that they send fibres from the anterior median fissure to the posterior lateral fissure, which forms the line behind which issue the posterior roots of the spinal nerves, and as the said columns advance upwards, they contract. The fibres that were previously expanded become convergent, and are found compressed between the pyramidal bodies and the cineritious tubercles;* and following them upwards, they are found strongly compressed, and, as it were, hidden between the corpora olivaria and the inferior peduncles of the cerebellum, on which account they have eluded the minute investigations of anatomists among these parts. For in order to see these fibrous cords distinctly, which are flattened externally and at the same time a little curved, it is necessary to separate the olivary bodies from the inferior peduncles of the cerebellum: in this place they are covered by the arciform filaments, to be spoken of shortly. Then, above this point, if you wish to follow the fibres of the said cords downwards, it is easy to see that anteriorly they are directed towards the inferior extremities of the olivary bodies and the pyramids, in order to form that portion of the medulla spinalis which folds into the anterior median fissure; whilst these find themselves in contact with the inferior peduncles of the cerebellum they bend backwards, carry themselves towards the posterior surface of the cineritious tubercles, and go to form the posterior lateral fissure. *It is more difficult to follow the anterior cords towards the superior region of the medulla oblongata.*" At this point his observation has failed him, for instead of tracing them, as he might have done, to the cerebellum, he goes on to say: "But one may often succeed in seeing them when they bend over the superior extremity of the olivary bodies, where is formed that space which Malacarne has called the fossa quadrilatera. Nevertheless, it is only by means of transverse sections, made and repeated at like distances, that the anatomist will obtain an exact idea of their arrangement at the part in question; in this manner they may get behind the above-mentioned cords, although hidden in the cineritious substance of the annular protuberance."†

The best method of dissecting the medulla oblongata, with a view of demonstrating clearly the existence of those fibres which connect the

* The cineritious tubercles are described as bodies situated on the lower part of the restiform bodies.

† Op. cit., p. 149.

anterior columns with the cerebellum, is, either to split the posterior column from the antero-lateral column, by raising only the posterior columns, or, in other words, that portion which is between the posterior lateral and posterior median fissure, about two inches below the pons Varolii; and drawing the portion thus separated very carefully up towards the cerebellum, the dissector will find that the splitting will be stopped before the cerebellum is reached by the superficial cerebellar fibres of the anterior columns, unless so much force is used that the superficial fibres are torn through without observation. Or another mode of dissecting them is to trace the sensory root of the fifth pair of cerebral nerves through the pons Varolii, down to its connection with the posterior portion of the antero-lateral column, in doing which a layer of fibres will be met with in the medulla oblongata about the thickness of hogs' bristles, running from beneath the olivary bodies on the outer side of the above-mentioned root of the fifth pair of nerves, to the cerebellum, forming a portion of the restiform body in their progress (fig. 90, w *w*).

The first set of *superficial cerebellar* fibres are represented (fig. 89, w *w*) passing upon the surface of the corpus restiforme. The second, or deep, set of the cerebellar fibres are represented cut through in their passage to the cerebellum, just as they cross the sensory tract of the fifth pair (fig. 90, w *w*).

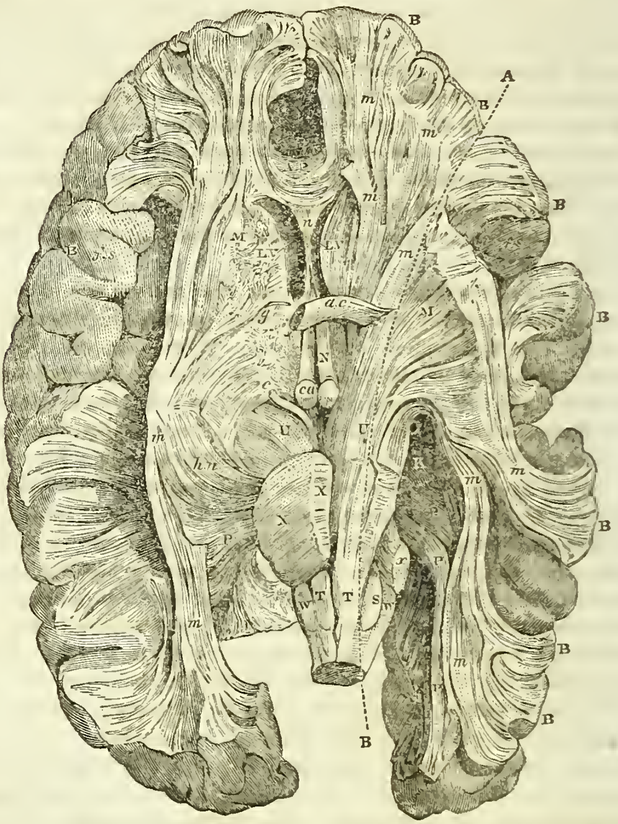
The fibres just described as connecting the antero-lateral columns of the cord with the cerebellum, are peculiarly interesting when viewed in relation to the functions of the cerebellum. For although it is true that its functions have not yet been clearly ascertained, the experiments of Flourens, Bouillaud, Magendie, and others, and the numerous cases on record in which disease of the cerebellum has been followed by paralysis, all tend to prove that the cerebellum is in some way or other connected with the regulation of muscular action, most probably, as before hinted at, that it has the power of combining the action of individual muscles so as to effect an harmonious result, such as is necessary to enable us to stand, walk, &c. Even Broussais, in his lecture on Phrenology, published in the Lancet, July 30th, 1836, acknowledges that the cerebellum is an instrument connected in some degree with the combined action of the muscles, though merely in relation to the act of copulation. Their presence also proves the weakness of Mr. Walker's theory of the function of the posterior columns, as derived from the supposed fact that the posterior columns alone are connected with the cerebellum.

This circumstance is also at variance with the opinions of M. Foville, who reasons that the cerebellum must be concerned in the phenomena of sensation, because the posterior columns are alone connected with it;* while Dr. Prichard, in his treatise on Insanity, and other disorders of the Mind, p. 482, after speaking of Foville's doctrines, and their foundation

* Dict. de Méd. et de Chirurg. Prat., tome vii. p. 202, art. ENCEPHALE. "Or nous voyons les cordons postérieurs de la moëlle, affectés à la sensibilité, se prolonger dans le cervelet; les cordons antérieurs, affectés au mouvement, s'entrecrosier dans les pyramides, poursuivre après cet entrecroisement leur marche vers le cerveau, dans l'épaisseur duquel ils pénètrent très profondement; et nous trouvons ainsi une raison anatomique de supposer que le cervelet doit avoir à remplir un rôle tres-important dans les phénomènes relatifs à la sensibilité, tandis que le cerveau jouirait d'une influence directe et centrale sur la production des mouvements volontaires."

upon what he considers an established fact in anatomy, says, with the usual caution of such a highly-talented observer: "In the present state of these researches, it would be a rash attempt to draw inferences with any degree of confidence; but I may be allowed to remark that the general bearing of facts seems to direct towards the conclusion that the two great organs inclosed within the skulls of vertebrated animals, belong respectively to the two principal functions of animal life, which are, first, sensation, conscious perception, and the physical phenomena related to intelligence; and, secondly, those of voluntary motion. This, however, can only be

Fig. 91.



This is from a dissection of a brain which had been hardened in spirits of wine It represents the base of the brain with the course of the fibres from the pyramidal or motor columns, on the left side exposed continuously from the pyramidal body (T), through the pons Varolii (X), which has been partly removed on that side, forming (U) the under part of the crus cerebri, plunging to the corpus striatum (M), emerging (*m m m m*) from thence, and running forwards, forwards and outwards, outwards and backwards, to the whole extent of the hemispherical ganglion (B B B). The course of some of the fibres of the superior longitudinal commissure, and also some of the fibres of the great commissure, are shown. B B B. Convoluted surface of the brain, or hemispherical ganglion. K. Thalamus optici divided. L N. L N. Anterior cornua of the lateral ventricle separated by N, septum lucidum. M M. Corpora striata. N. Anterior pillars of the fornix running from the *c a*, corpora albicantia. P P. Posterior extremity and under surface of the great transverse commissure, or corpus callosum. P P. Fibres continued to the posterior lobe. A P. Anterior extremity of ditto. S. Corpus olivare. T. Corpus pyramidale. U U. Crura cerebri. W W Corpus restiforme. X X. Pons Varolii, *x*. divided end of it, where it enters the cerebellum. *a c*. Anterior commissure, divided a little to the right of the mesial line. *g*. Groove in the corpus striatum. from which it has been removed. *c*. Third pair of nerves. *f s f, s*. Fissura Sylvii. *h n*. Descending fibres of the fornix over the hippocampal convolution.

considered as a probable opinion. Such it has long been thought by many physiologists; and though the grounds on which this conclusion rests, appear to be more secure than they formerly were, the proof is still defective."

The anterior portion of the anterior columns, that which is usually called the corpus pyramidale (T, figs. 72, 85), may be now traced through the pons Varolii; but before doing so, the student had better make himself acquainted with the structure of the commissure: for this purpose let him refer to the description of the commissures.

If the student pull upwards by means of a scoop director, the inferior edge of the pons Varolii from the anterior column, or *corpus pyramidale*, he will find it contracted as it enters this commissure to a small, strong, rounded cord.

Following this cord behind (see fig. 91, and description) the most superficial fibres of the pons Varolii, or *beneath them as he dissects*, and tearing them backwards towards the cerebellum, he will soon find that the fibres of the anterior columns diverge from one another, and become separated by the transverse fibres of the commissure through which he is now tracing them. This is best seen by fig. 87. It is also important that he should be aware, in performing the above dissection, that these fibres from the spinal cord take a curved direction through the pons Varolii, the convexity forwards; otherwise he will be liable to tear them by going too deep at the central part of their course, taking them from above to below.

The fibres thus traversing this *body* (for, as I have mentioned elsewhere, it cannot be considered a mere apparatus of *transmission* or *commissure*), emerge beyond it, and at its upper edge, form the under portion of a structure, which has been already noticed under the old name of crura cerebri (U), and which, diverging from its fellow of the opposite side, forms the outer and posterior boundary of the diamond or lozenge-shaped space of the base of the brain (see fig. 72).

The crura cerebri, thus viewed from below, appear to be mere round flattened cords, consisting only of fibrous neurine derived from the anterior columns. A perpendicular section, (as represented in fig. 92, *ln*) demonstrates the presence of some very dark pulpy neurine; this has been called the locus niger; I would rather designate it *the ganglion of the third pair of nerves:* for a portion of the central extremity of this nerve traverses this gray matter, and is split by it into five or six filaments, which become connected with a portion of the inter-cerebral commissure, as described further on. Posterior to this ganglion are more white fibres: these belong to the posterior portion of the lateral column, the sensory columns of Sir Charles Bell.

These right and left anterior columns, in their passage through the pons Varolii, are separated from each other by a peculiar structure, first described by Sir Charles Bell, and represented in the Philosophical Transactions for 1834, as resting with its edge on the commissure of the cerebellum, and extending its fibres directly backwards, so as to form a striated leaf, separating the two great longitudinal tracts which pass between the medulla oblongata.

In making sections of the pons Varolii, it is a curious fact that those

parts, which appear gray on a transverse section, are white on a longitudinal, and *vice versâ*.

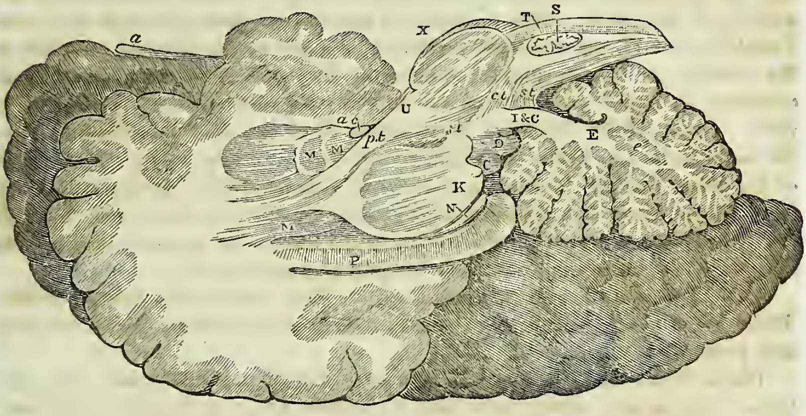
The next step in the dissection is, to remove the arachnoid and pia mater from the fissura Sylvii, through which fissure the dissector may insert his fingers, and raising the middle lobe tear, through its connections with the anterior so completely as to enable him to turn it back over the posterior. This will expose a white flattened band crossing the crus just where the body plunges into the cerebrum (see fig. 72, on the left side); this band is called the *tractus opticus*, and is placed between the commissure of the optic nerve, and its cerebral connections; let this be divided, and the handle of a scalpel or scoop of a director be placed on the surface of the crus, and then removing the neurine which overlaps the crus, the student will be enabled to trace further the motor tract of fibres of the anterior column. By gradually removing the neurine which still covers them, he will expose some medullary fibres running from before backwards; these belong to the great transverse commissure or corpus callosum. On removing these he will come to a large deposit or bed (M M), if we may so express it, of cineritious neurine, through which the anterior columns pass, exactly in the same manner that the sensory fibres of the fifth pair do through the semilunar ganglion already referred to in the sphenoido-temporal fossa. This collection of neurine is the ganglion of the anterior columns or motory tract, and is commonly known by the name of the *corpus striatum* (M M). In all the figures these letters designate it. By gradually scraping the substance of this ganglion away. and carefully following the white fibres, the exact course of the motory tract (*m*, *m*, *m*, *m*) will be exposed. In the course of scraping the cineritious neurine away, a rounded band of medullary neurine will be exposed, taking its course from the circumference of the brain forwards and inwards: this band is the commencement of the anterior commissure (*a c*).

The motory fibres, which are thus traced into the substance of the corpus striatum or anterior cerebral ganglion of the cord, spread as they emerge from its external edge, and pursuing their course in different directions like the rays of a fan, some passing forwards, others outwards and others backwards, terminate ultimately in the cineritious neurine composing the convoluted surface of the hemispheres, the *hemispherical ganglia*, fig. 91, B B B.

When the student has not the opportunity of tracing these fibres of the pyramidal bodies, or anterior columns of the cord, in a brain hardened in spirit, he will obtain a very good view of their course, and especially their relation to the corpus striatum, by a perpendicular section from the medulla oblongata through the pons Varolii, crus cerebri, corpus striatum, and hemisphere of the brain, in the direction indicated by the dotted line, A B, in fig. 91. The appearance which this section exhibits is represented in fig. 92. This is a useful section when we examine the brain for pathological investigation; it gives a continuous view of the motor and sensory tract, and readily exposes any morbid appearance in its course. Gall and Spurzheim have given a very beautiful representation of this tract, as viewed from below, in their larger work on the brain.

Cruveilhier* describes these columns as passing through the thalami nervorum opticorum in addition to the corpora striata. The same author also refutes the opinion of Reil, Gall, and Spurzheim, that these fibres are reinforced, as it were, or augmented by their passage through the corpora striata.

Fig. 92.



The brain is laid on its upper surface, and a section has been made longitudinally through the medulla oblongata, pons Varolii, cerebellum, anterior and posterior cerebral ganglia, fornix and corpus callosum, anterior commissure and left hemisphere of the brain, in the direction indicated by the dotted line in fig. 91. I & C. Inter-cerebral commissure. C D. Optic tubercles. E. Cerebellum and corpus dentatum. K. Optic thalamus. M. Corpus striatum. N. Fornix. P. Corpus callosum. S. Olivary body. T. Corpus pyramidale. U. Crus cerebri. X. Pons Varolii. *a*. Olfactory ganglion. *a c*. Anterior commissure. *o t*. Olivary tract. *p t*. Pyramidal tract. *s t*, *s t*. Sensory tract.

Wenzel, with his usual accurate minuteness, enters into the question of the relation of the cortical substance of the brain to the white fibre, in the following words :†—"Utrum cinerea substantia quæ in exteriore cerebri ambitu reperitur, cum illa ex qua partes in interiore cerebro sitæ constant, cohærent nec ne ?" He sums up his observations as follows :‡—"Substantia cinerea interiorum cerebri partium, nominatim striatorum corporum, et colliculorum nervorum opticorum nullo totius sui ambitus loco, cum ea quæ ad exteriorem cerebri ambitum pertinet substantia cinerea immediata cohærent."

The anterior division of the antero-lateral columns of the spinal cord, or the motory tract of neurine, has thus been traced from the point where, going by the name of corpus pyramidale, it forms part of the medulla oblongata—1st. Through the pons Varolii or commissure of the cerebellum ; 2dly. Forming the inferior part of the crus cerebri ; 3dly. Plunging into the anterior cerebral ganglion or corpus striatum ; and 4thly, and lastly. Quitting this ganglion in order to reach the hemispherical ganglion, or the cineritious neurine of the convoluted surface of the hemispheres. The posterior division of the same column has been traced to the cerebellum. It now remains to trace the middle division in its upward course from the olivary bodies through the pons Varolii to the cerebrum, forming in its course connections with the optic tubercles and thalami.

* Op. cit., p. 716. † Op. cit., p. 64. ‡ Op. cit., p. 69.

The student, after he has traced these fibres of the anterior columns, must return to the medulla oblongata, and slice off the surface of the corpus olivare, commencing his incision at the lower part of this body and carrying it up through the pons Varolii into the outer side of the crus cerebri: by this section he will first expose the interior of the olivary bodies (figs. 87, 92, s), surrounded by the fasciculi of white fibres, one set passing before and one behind them. These two fasciculi reuniting at the upper edge of the olivary bodies, pass through the pons Varolii (*o t*, *o t*), on a plane posterior (deeper in the present position of the brain), to the pyramidal columns; they are separated from these columns by about a quarter of an inch of the substance of the pons Varolii. Some of the fibres of these fasciculi of the olivary columns, viz., the most anterior, again join the pyramidal columns at the upper edge of the pons Varolii, forming a portion of the outer part of the crus cerebri. These fibres run partly behind, partly on the outside, partly through the locus niger; they lie anterior and external to the sensory tract of the antero-lateral columns described further on (see fig. 87).

This fasciculus has been described by Reil* under the title of Fillet. This author describes them as continuous with both the corpora olivaria and pyramidalia.

These fibres, as they traverse the pons Varolii, separate into two portions; one passes inwards to join its fellow, so as to form a curvilinear stratum of fibres immediately below the optic tubercles.

The other portion, described by Mayo as the fasciculus of the olivary body, ascends to the crus cerebri, and passes through the locus niger. Sir C. Bell describes this fasciculus as *entirely emanating from the olivary body*. This description does not altogether accord with my own dissection: for after many repeated and patient dissections of the lower extremity of this fasciculus, I invariably found that most of its fibres passed either partly before, or partly behind; the former being frequently continuous with the pyramidal columns, the latter with the antero-lateral, though a *portion* of these fibres clearly run *into* the olivary bodies, as may be seen in fig. 87, *o t*.

The most accurate mode of dissecting these fibres, and the least liable to error, is to make a section of the pons Varolii and medulla oblongata, previously removed from the rest of the brain, including a piece about an eighth of an inch in lateral width, or half of the corpus pyramidale and corpus olivare; in that way these fillets are exposed: and then tearing this piece downwards, commencing the rent in front of the fillet, and thus separating it from the pons Varolii, its fibres may be traced continuous with the pyramidal bodies and running in front of the olives; a second rent made behind the fillet will separate it from the portion of the lateral columns which ascend to the thalami, and show those fibres which run behind the olivary bodies. Dr. Reid, in his excellent paper on the medulla oblongata, (Ed. Med. and Surg. Journal, 1841,) describes these olivary columns; but he does not state that they go through the olivary bodies, or that there is any connection between the fibres of the columns and the gray matter of the olive.

* Op. cit., p. 94, part ii.

This author points out more clearly, I believe, than any one else, the motor character of this tract; and this seems to confirm my view, that it is a portion of the antero-lateral. I am, however, inclined to believe that some of these fibres are *commissural* between the olivary bodies and the optic ganglia; though I do not quite understand, if there is a functional connection between the fibres and the olivary bodies, that they do not stream through the vesicular neurine as the motor tract does through the corpus striatum, &c. Mayo, in his beautiful plates of the brain, though he exhibits these columns (which he, like others, designates as olivary), running round the olives, but not through them, nevertheless speaks of them as derived from them.

In the section on Comparative Anatomy, I have adduced, I think, sufficient evidence to show that the position of the olivary bodies varies considerably, and in some animals they are even imbedded in the pyramidal bodies, which goes far to show the physiological identity of the great mass of the olivary and pyramidal columns.

Dr. Reid says, and I fully agree with him, "If we trace these olivary columns downwards, we observe that they form attachments to the anterior roots of the first and second cervical nerves, and that they continue their course onwards in the line of the other anterior roots of the spinal nerves. We can, then, have little difficulty in arriving at the conclusion that the olivary is a motor column. On tracing this column upwards, we find that where it embraces the olivary body, the *portio dura* is attached to its outer margin, and the hypoglossal and abducens nerves are partly attached to its inner margin, and partly to the outer margin of the pyramidal column. On tracing the two roots of the fifth pair, the smaller or motor root can be followed to that portion of the olivary column which proceeds to the optic lobes,—sometimes running down the outer or external edge of the pons, to reach the portion of the olivary columns already mentioned as it emerges from the external margin of the pons; at other times its course is observed by a greater or less number of the transverse fibres of the pons crossing it. The trochleator nerve is attached to the internal margin of the same band of fibres when it has ascended the processus è cerebello ad testes, and is about to enter the optic lobes."* He also describes the connection of the portio dura, lingual and abductor nerves with the inferior portion of it.

The olivary column is then a compound tract, *commissural* and *nervous*. The commissural portion emanates from the interior of the olivary bodies, (see fig. 87,) and this I shall designate the *olivary commissure*. The nervous portion belongs to the motor system of nerves, and is physiologically a portion of the pyramidal tract.

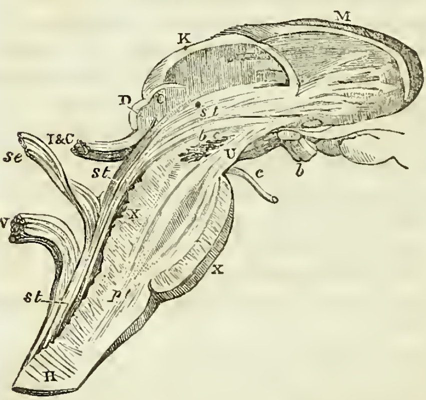
Dr. Reid describes, and I think justly, the pyramidal columns as passing into the middle columns after their decussation; he describes the arciform fibres as going to join the posterior or cerebellar column as I first described them, but he is in error in attributing to Santorini, Gall and Spurzheim, Rosenthal and Rolando, a knowledge of the fact that they form a communication between the anterior portion of the cord and cerebellum, which I consider an important anatomical discovery alone due to me.

* Ed. Med. and Surg. Journal, Jan. 1, 1841.

We must now return to the medulla oblongata for the purpose of tracing those tracts of neurine which Sir Charles Bell has proved to be employed in conducting sensation. It has been already stated that in the composition of the spinal cord we can observe no line of demarkation by which the tract of sensation may be distinguished from that of motion, but that a portion of the cord anterior to the posterior fissure is distinctly ascertained to be appropriated to this function; I shall assume, therefore, that the line of demarkation is about the middle of the lateral aspect of the cord, and that the sensory column, or tract of sensation, consists of two portions, the one posterior to the fissure referred to, and consequently named the posterior column, the other anterior to it, constituting part of the antero-lateral column. These two portions had better be traced separately. Commencing with the posterior division, or, in other words, the posterior columns, we find them ascending to the cerebellum, and in their course to that mass forming a portion of a body previously noticed in describing the anterior columns, viz., the *corpora restiformia.*

In their passage to the cerebellum, as a portion of the constituent fibres of these bodies, they are partly overlapped by, and partly interlace with, those fibres from the anterior columns which, ascending to the cerebellum, connect the motor or voluntary tract of the spinal cord with the cerebellum as well as with the cerebrum; and let me again repeat that the fibres which compose the corpora restiformia are not arranged in the simple, regular, parallel manner in which we find them in the body of the cord, but interlace, forming rather an intricate plexus.

Fig. 93.



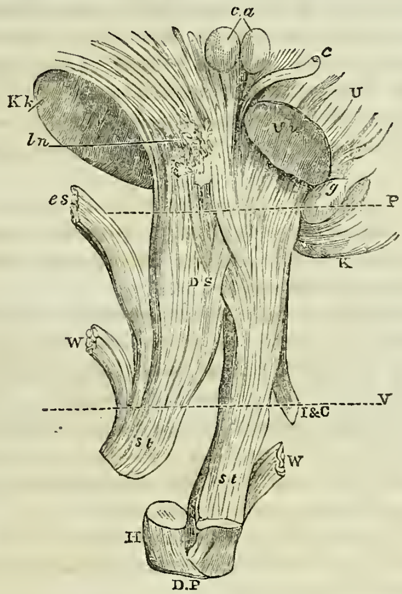
This drawing is from a dissection made on a piece of brain which had been hardened in spirits. It exhibits the course of the sensory columns from the medulla oblongata to the thalamus. Their function I consider proved by the fact that the sensory root of the fifth pair of nerves is connected with them. C. Anterior optic tubercle. D. Posterior ditto. I & C. Inter-cerebral commissure, or processus è cerebello ad testes. H. Spinal cord. K. Thalamus optici. M. Corpus striatum. U. Crus cerebri. W. Corpus restiforme. X X. Pons Varolii. *b.* Optic nerve. *c.* Third pair. *b c.* Locus niger. *p t.* Pyramidal. or motor tract. *s t, s t, s t.* Sensory tract,—the posterior third of the antero-lateral column. *s c.* Sensory root of the fifth pair of nerves.

The *cerebral fibres of the sensory columns.*—The remaining portion of the tract of sensation, or that portion of the sensory column which, in the spinal cord, is anterior to the fissure, from which the posterior roots of the spinal nerves emerge, and whose line of demarkation from the motor tract is about the middle of the lateral aspect of the cord, must next be traced to its destination. In the first place we find it sending a few fibres, like the posterior columns, to the cerebellum; the rest of its fibres ascend principally to the cerebrum.

The proof that the columns, which we are now about to trace to the cerebrum, form a portion of the tract of sensation, is derived from the fact that the sensory root of the fifth pair of nerves arises from it, see

fig. 93.* In the medulla oblongata, the cerebral sensory tracts lie in contact with each other in the mesial line. In the fourth ventricle, or calamus scriptorius, they are covered by the auditory ganglia, or posterior pyramidal bodies. From this part they ascend behind the pons Varolii, where they form the floor of the iter a tertio a quarto ventriculo. In this situation they decussate with their corresponding fibres on the opposite side (see fig. 94).

Fig. 94.



This figure I sketched from a dissection made on the same brain as that from which fig. 91 had been taken, and the two may be advantageously compared. The whole of the pyramidal and olivary bodies, and their respective tracts, have been removed, and the posterior part of the cord left. D P. Decussation of the pyramidal bodies. D S. Decussation of the cerebral *sensory tract*, or posterior third of the antero-lateral column. I & C. Inter-cerebral commissure divided. K. Posterior extremity of the thalamus nervi optici. K *k*. Divided end of the same. *g*. Corpus geniculatum externum. U. Crus cerebri. U *u*. Divided end of the same. W W. Corpora restiformia. *c*. Third pair of nerves. *c a*. Corpora albicantia. *e s*. Sensory root of the fifth pair. *l n* Locus niger. *s t*. Cerebral sensory tract. P V. Dotted lines marking the situation and width of the pons Varolii, behind which the decussation takes place.

The presence of such a decussation for the sensory tract has long been suspected, as it was proved to exist for the motor tract.

Sir Charles Bell believed that he had discovered it, but he placed it too low down, and, as I have stated elsewhere, in all probability mistook the posterior surface of the pyramidal decussation for a distinct decussation. The best mode of demonstrating this interlacement, is, first, to separate the medulla oblongata, with the pons Varolii, crura cerebri, and optic thalami, from the rest of the brain. Secondly, divide the pons Varolii anteriorly, in a longitudinal direction, through the centre to the depth of half an inch; divide the pyramidal decussation; then take the

* I am delighted to find that Stilling, in his new work on the Pons Varolii, has accurately figured all these fibres.

two lateral halves of the cord and split them upwards, tearing through the floor of the fourth ventricle. When the rent passes the roots of the auditory nerve, fibres, the size of ordinary ligature silk, may be seen running obliquely across the mesial fissure, from one side to the other. decussating with their fellows. This decussation may also be demon strated anteriorly, as represented in fig. 94, though it requires more care and some dissection. This decussation may be seen in the sheep as distinctly as in the human brain. I have not looked for it in any other animal.*

After this decussation, on their emergence from behind the pons Varolii, the fibres of the sensory tract form the upper part of the crus cerebri, separated in that body from the motor tract by that deposit of cineritious neurine called the *locus niger*, as previously mentioned: the sensory tract, where forming the upper layer of the constituent fibres of the crus cerebri, is covered superiorly by the optic tubercles and the inter-cerebral commissure.

These structures must be raised, in order to expose its course in this situation. From this point they plunge into their appropriate ganglion, the *posterior cerebral ganglion*, better known, as before stated, by the name of the *thalamus nervi optici.*

The course of the fibres through the *posterior cerebral* ganglion is not so distinctly marked as that of the motor tract through the anterior; for here the medullary fibres are not so decidedly separated from the cineritious; the two appear more intimately mingled. From the outer side of the posterior cerebral ganglion, the medullary fibres issue forth, spreading in every direction until, meeting with the convoluted surface of the brain or the cineritious neurine of the hemispherical ganglia, their progress is arrested and their course terminated.

A side view of the course of this tract through the *posterior cerebral ganglion*, or thalamus nervi optici, and its expansion in the hemispheres, is well shown in Gall's large work.

The relation of the motor and sensory columns of the cord, as forming part of the cerebrum, with their appropriate ganglia, is thus described by Sir Charles Bell in his paper in the Philosophical Transactions above referred to: "The thalamus forms a nucleus round which the corpus striatum bends, and when their respective layers of striæ make their exit beyond these bodies to form the great fan, or solar-like expansion, into the hemisphere of the cerebrum, their rays mingle together. A rude representation of these two parts of the cerebrum, as we have traced them, may be made with the hands. If I place my wrists together, parallel, and closing one hand, embrace it with the other, I represent the two

* Foville does not describe any decussation of the posterior columns, but he figures this decussation, though, as it appears to me, in an exaggerated manner. "Pl. 2 (Foville), fig. 4. F. Point of the calamus: from this point, up to c′, may be observed the *entre croissement* of the two halves of the medulla oblongata." Longet (vol. i. p. 382) says, "We have long known that all the fibres of the antero-lateral columns of the spinal marrow are far from intercrossing at the place designated for the decussation of the pyramids. But in separating the posterior median fissure of the bulb and protuberance just below the tubercula quadrigemina, M. Foville has pointed out a superior interlacement, which, without doubt, effects in part a union between those fibres of the antero-lateral columns which Rolando described, and Cruveilhier designated the fasciculus of reinforcement of the bulb, or *faisceau innomé*."

portions of one crus. The closed fist is the thalamus, and the other is the corpus striatum. If I then extend my fingers, interlacing their points, I represent the final distribution of the portions of the nervous matter which are dedicated to sensation and volition."

The best mode of dissecting these parts, for the purpose of tracing the sensory columns, as just described, and which perhaps will give the most correct ideas of their relative position to the parts with which they are connected, is to lay the brain upon its under surface, and then to make a perpendicular section through the mesial line, from before to behind, of the whole cerebral mass. This section will divide, it is true, all the transverse commissures; all those structures, in fact, which connect together corresponding parts placed on opposite sides of the mesial line; consequently, these apparatuses of union must be studied in another brain, should they not have been previously traced as suggested above. The similarity of the parts exposed by this section to those composing the cerebral mass of the turtle, cannot fail to arrest the attention of the student.

Let me remark, that though most of the parts to be observed in the following view, have been already described under a different aspect, I speak of them again without reference to the previous notice. Commencing from behind, and proceeding forwards, may be observed (fig. 100):

1. The *medulla oblongata*, divided in the mesial line. Anterior to this, and rather superior to it, is,

2. The *pons Varolii*, or commissure of the cerebellum. Above and behind the pons is,

3. The *cerebellum*, presenting that curious and beautiful appearance resulting from the disposition of cineritious and medullary neurine, called the *arbor vitæ*. If the student carry his eye along that portion of the medullary neurine which corresponds to the stalk of the tree, he will find it emerging from the cerebellum, and turning up to a little rounded body about the size of a small pea; immediately anterior to which is another of rather larger size: the two together are,

4. The *optic tubercles*, or *corpora quadrigemina*, the posterior being the testes, the anterior the nates.

The structure which has been likened to the stalk of the tree, will be recognized as the commissure connecting the greater cerebral mass to the lesser, in other words, the cerebrum to the cerebellum; this is,

5. The *inter-cerebral commissure.*

Beneath the optic tubercles we observe, rising up, as it were, from the pons Varolii, a structure previously mentioned, namely,

6. The *crus cerebri.* A section of this part shows it to consist of medullary neurine above and below, with cineritious interposed between the two. The medullary neurine, which is above the cineritious, is the sensory tract, that below, the motor tract. The cineritious neurine has been long known to anatomists by the name of *locus niger*. Immediately in front of the crus and optic tubercles is a rounded nodule of considerable size, being about the same dimensions as the pons Varolii, called

7. The *thalamus nervi optici* by anatomists of the old school, the *posterior cerebral ganglion* of the cord by more modern teachers.

Anterior to this ganglion, and partly overlapping it, will be observed some fibres, which, appearing to spring from the under part of the brain, run backwards and upwards; these fibres form a portion of a longitudinal commissure or fornix.

If these fibres be removed, another rounded nodule of neurine will be exposed, which has been already observed upon its under surface; this is,

8. The *corpus striatum*, or *anterior cerebral ganglion*, in front of and behind which, are

9. The hemispheres, formed of the fibres of the cord, commissural fibres, and hemispherical ganglia.

The structure of the hemispherical ganglia, or cortical substance of the brain, may next be examined. Their enormous size in the human being, as compared with those in the lower animals, has been already adverted to. The extent of the convoluted surface is well seen in both an horizontal section (figs. 77 and 78), and perpendicular section (fig. 95).

These ganglia do not consist of one single layer of cineritious neurine, but of three layers alternating with three layers of medullary neurine. The distinction between some of these layers may often be seen with the naked eye in the posterior convolutions in a state of health. But this stratification is still more evident after disease. When the cortical substance has been long the subject of chronic inflammation, as in old cases of insanity, it is peculiarly distinct. In the section on pathology, some cases will be detailed. The white fibres may be traced through these layers, as we have traced them through the corpus striatum.

Fig. 95.

This drawing having been taken from a preparation which had been some time in spirit, the upper surface is unnaturally flattened. It exhibits a transverse section of the brain taken a little posterior to its centre, measured from before to behind. It partly shows the enormous extent of, B, the hemispherical ganglion. M. Anterior cerebral or corpus striatum; the broad white line just below the letter, dividing it into two portions, is the motor tract. P. Great transverse commissure X. Pons Varolii. The great depth of the fissura Sylvii may be seen on both sides of the brain. It is most distinct on the right side of the figure between the two B B.

To the superficial observer this ganglion appears to consist of a single layer of cineritious neurine. A little care is sufficient to enable us to see with the naked eye that there are at least two layers of gray matter separated by a white layer. This is often most distinctly seen in a brain that has been in a state of chronic inflammation. It is also more distinct in the posterior than in the anterior convolutions. Vicq d'Azyr first pointed this out in the posterior portion of the brain, and Casanvielh demonstrated its existence throughout the whole.* M. Baillarger, in 1840, stated that, under the microscope, this ganglion will be found to consist of six layers, three of gray alternating with three of white.

The first going from within to without, is gray; the second, white; the third, gray; the fourth, white; the fifth, gray; and the sixth, white (see fig. 96, left half of the drawing).

Fig. 96.

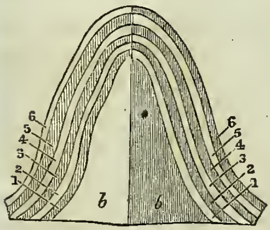


Fig. 97.

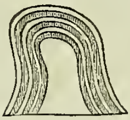


Fig. 98.

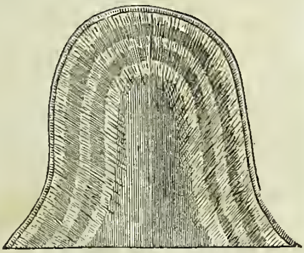


Fig. 96.—Magnified representation of the cortical substance of the brain of the sheep. (Baillarger.) The *left* half is seen as an opaque object; the *right* as a transparent one. Left half.—B. Tubular neurine of the hemispheres. 1, 2, 3, 4, 5, 6. The six alternate layers of gray and white neurine. Right half.—The white substance looks dark, and the gray neurine light. The numbers the same.

Fig. 97.—Convolution from the human brain, single aspect; six alternate layers.

Fig. 98.—This figure shows the passage of the fibres through the layers of the hemispherical ganglion. The left half is from the human brain; the right from the brain of the pig.

These six layers can be distinctly made out with the microscope. Under the glass, the appearance is reversed, the gray being transparent, and the white opaque (see the right side of fig. 96).

This author states that he has examined the gray substance of the hippocampus, and that he has found it striatified like that of the convolutions, which he considers a proof that this is an internal convolution, as I have stated elsewhere.

The tubular fibres from the hemispheres pass through these three layers of vesicular neurine (see fig. 98).

These fibres, which are very long and numerous at the summit of the convolutions, become shorter and more scanty at their base. At the bottom of the anfractuosities, these fibres are so short that in some brains we can separate them from the cortical substance without rupturing them.

Baillarger asserts positively that the external layer of the brain is white, and not gray, as has been usually supposed. This color is most evident in the brain of infants, old people, the insane, and of some animals.

Mr. Grainger informs me that his own observations by the microscope on the cortical substance, quite accord with M. Baillarger.

Regarding the structure of the cortical substance in the lower animals,

* Mém. de l'Acad. de Méd., tom. viii. 1840.

M. Baillarger states, that in the fish he observes no stratification of this ganglion. In the class Amphibia he has only examined the frog, and that he has not been able to observe any stratification in this ganglion. In the brain of the bird there is only *one* white line. He found six in the brain of all the Mammalia he examined.

Commissures.—In commencing this new inquiry, the student must remember that the commissures or apparatuses of union can only be thoroughly understood, and their exact connections and relations appreciated, after a diligent consideration of the exact relative position of the different ganglia which it is the office of these commissures to connect together.

Spurzheim confines the word *commissure* to designate structures which connect corresponding parts, and applies the term instruments of communication to those which connect different parts on the same side; a distinction which, as it does not appear to me to be attended with any advantage, I have taken the liberty of rejecting.

Let the brain be now laid upon its under surface, when of course the upper surface of the hemispheres will meet the eye.* Let the membranes be removed from these, and the depth of the fissures separating the convolutions, as well as the general exact correspondence or symmetry of the hemispheres of the brain, be remarked. The great fissure separating them longitudinally is deep; at the bottom of it a broad band of fibrous or medullary neurine will be observed; this is the *great transverse commissure*, or corpus callosum (figs. 77, 92, 95, 99, 100, P, the same letter in all). Before entering on the description of this part, let me remind the student of the simple form in which a commissure was first presented to his notice in the nervous system of the star-fish, where it appeared as a slender cord of neurine connecting one ganglion with another.

In this description of the human brain I shall consider under the head of commissures all those collections of medullary neurine which are so arranged as to connect either corresponding parts which are placed on each side of the mesial line, as, for instance, the right and left hemispheres; or different organs on the same side, as the various convolutions of each hemisphere; or two distinct structures, as the two grand divisions of the encephalon, the cerebrum and cerebellum; thus following out to its fullest extent the principles which have been laid down elsewhere, that a ganglion is a collection of neurine of any size and of any form, and that the cerebro-spinal axis, of which the brain is a part, is no more than a collection of ganglia of immense size connected together by commissures of corresponding dimensions.

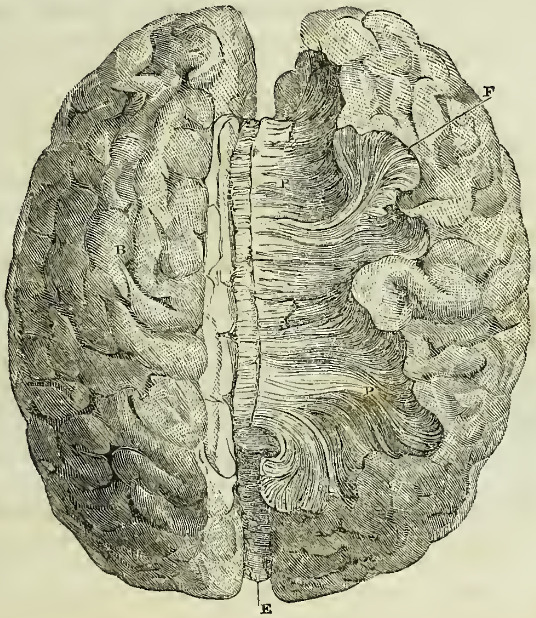
Transverse Commissure.—The great *transverse commissure*,† or corpus

* Supposing the student only to have one brain at his disposal, he must replace the portion of the right hemisphere which he removed when directed to make the section exposing the *centrum ovale.*

† Vicq d'Azyr was the first anatomist who described the corpus callosum as a commissure, while, on the other hand, Rolando denies that it is entitled to the name of a commissure; for, says he, "laying together the observations of Wenzel and Tiedemann upon the formation of the corpus callosum, and my own observations on the union of the cerebral vesicles,—the point of union constituting the future corpus callosum, this is obviously, in the first instance, no more than a contraction of the superior and inferior margins of the vesicles; the part cannot, at any rate, be justly described as a commissure."—*Op. cit.*, p. 72.

callosum, is a body consisting of fibres of medullary neurine, the extremities of which are everywhere in contact with the internal or central surface of the cineritious layer which forms the convolutions of the hemispheres—the hemispherical ganglia. These fibres consequently establish a communication between the cineritious neurine of the whole convoluted surface of both sides of the cerebrum.

Fig. 99.



This figure I sketched from a dissection which I made in company with my friend Mr. Grainger, whose testimony of its accuracy I am glad to quote, though it is opposed to the views and dissections of M. Foville. It is intended to show the course and connection of the fibres of the great transverse commissure of the hemispheres or corpus callosum. The dissection has only been carried into the right hemisphere. It will be seen that these fibres ascend to the convolutions above the mesial line. P P P. Fibres of the corpus callosum radiating into the hemispherical ganglion. B. Left hemispherical ganglion undissected. E. Cerebellum. Near the centre of the drawing, and a little to the right of the mesial line, is the representation of a broken fasciculus of fibres—the part torn off was traced most carefully into the convoluted surface of the brain.

Strictly speaking, the fibres of the great transverse commissure do not commence on one side more than another; but with the hope of assisting the mental eye in following their course from hemisphere to hemisphere, these fibres shall be described as originating on the right side and crossing over to the left. The fibres from the front, sides and superior part of the anterior lobe, then, pass backwards and inwards to the distance of an inch and a half from the anterior extremity of the cerebrum, where they cross the fissure which divides the two hemispheres. The anterior edge of the commissure consequently forms the posterior boundary of the anterior part of the fissure. In this situation the fibres are folded one upon another; so that on a transverse section of the commissure the anterior edge appears thicker than the centre, though it is not so thick as the posterior edge (see fig. 100).

The fibres from the convolutions of the upper part and sides of the middle lobes run downwards and inwards, being joined by those from the convolutions at the base of the brain.

Those again, from the upper, under, and posterior surface of the posterior lobe, run forwards and inwards to cross the fissure at the distance of nearly three inches from the posterior extremity of the cerebrum. The fibres from such extensive surfaces are necessarily numerous, and give a considerable thickness to the posterior edge of the commissure.*

All these fibres may be easily demonstrated in a brain that has been immersed for some time in spirits, and they may also be shown, though not so readily, in the fresh brain. The best method of exposing them is gradually, by tearing, to remove the upper part of the hemispheres, the handle of the knife being pushed into the horizontal fissure through which the commissure creeps, as it were, under the convolutions on both sides of the hemispheres. The dissection here had better be confined to the right side, in order to reserve the left entire for other observations, as in the preparation from which fig. 99 has been drawn.

Let me again repeat that I consider these connecting fibres of the great commissure as performing the same office, and that they ought to be considered as perfectly analogous structures to the single commissural cord which we met with in the star-fish. Their vast number, which is only in proportion to the great extent of surface from which they originate or which they connect, ought not to deceive us as to their similarity, and thus withdraw attention from the illustration of their real character afforded in the simple type of the nervous system as it exists in that animal.

The mode of tracing the fibres of the transverse commissure recommended will open the lateral ventricle, as previously described. But let me again remind the student, that this space must not, however, be viewed in the light of a cell or cavity situated in the interior of the brain, the walls of which are formed by the cerebral mass; but that he must consider it as resulting merely from the contact of the different surfaces of the brain. The external surface of the anterior and posterior cerebral ganglia, or the figurate surface, is here in contact with the internal smooth surface of the superficial cerebral convolutions or hemispherical ganglia.

The next commissure to which our attention should be directed is a longitudinal commissure. I have designated it *the superior longitudinal* commissure (see fig. 100), in distinction to the fornix, which I have called the *inferior longitudinal* commissure; the former being situated *above* the great transverse commissure, the latter below it. In most

* M. Foville, *op. cit.*, gives a very different account of the nature of the corpus callosum, and the origin of its component fibres. He considers that they commence from the corpus striatum and thalamus, and says they have nothing to do with the hemispheres, but in reality form a commissure between the two crura cerebri of a vaulted form. Mayo, in his Outlines of Physiology, has very clearly proved the manner in which that mistake has occurred, and shown that Foville, in producing the appearance which induced him to adopt the opinion stated above, breaks through the point where the fibres from the columns intersect the commissural fibres, and then follows the columnal fibres in their course to the striated bodies. Rolando advances the same opinion regarding the composition of this commissure as Foville, quoting the opinions of Tiedemann in support of his own. Notwithstanding such weighty testimony, I am convinced from repeated dissections that they have been deceived, most probably as explained by Mayo in his Physiology.

systematic works we do not find any mention whatever made of these fibres. Mayo, with his usual accuracy of observation, has delineated them in his Plates of the Brain, showing on their external aspect, what I have exhibited on their internal, in fig. 100, where they are represented as they run above the transverse commissure on the edge of the longitudinal fissure. Mayo did not give them any distinctive or generic appellation. These fibres may be easily seen by removing the surface of the convolutions where they form the lower part of the outer wall of the above fissure.

Fig. 100.

This figure represents longitudinal fibres placed above the great transverse commissure corresponding with those which we have just observed below it—*the superior longitudinal commissure.* The relations being more simple than those of the inferior commissure, are simply designated by the letters S L. S L. They are traced, ascending forwards, from the locus quadratus, which is anterior to the fissura Sylvii, and then, curving backwards and winding round the front of the great transverse commissure (P), receiving fibres from all the convolutions at the upper and sides of the hemispheres, winding round the posterior extremity of the same commissure, and terminating after crossing the fissura Sylvii, where it commenced in the locus quadratus at the base of the brain. H. Spinal cord. J. Pituitary gland, just above which is the divided optic nerve. X. Letter placed on the crus cerebri. and behind that root of the fornix which springs from the interior of the thalamus. P. Great transverse commissure. S. Olivary ganglion. *a.* Olfactory ganglion. C D. Optic ganglia. C *a.* Corpus mammillare, formed by the twist of the fornix. *c m.* Commissura mollis in the third ventricle. *k.* Optic thalamus. *o.* Peduncle of the pineal gland: if this line is traced backwards it will be found connected with a dark rounded body, the pineal gland, which is lying on the anterior optic tubercle—nates; if this line is traced forwards it will be seen joining the anterior pillar of the fornix, which has been turned down to show this connection. The divided end of the fornix is turned towards us. *p c.* Posterior commissure. S. Tænia semicircularis joining the fornix at the same point. This letter is placed in the anterior cornu of the lateral ventricle on the corpus striatum. This junction is very distinct in both the recent and hardened brain, though the connecting fibres are too delicate to be done justice to in a woodcut. 4. Fourth ventricle. P. Iter a tertio ad quartum ventriculum. U. Posterior commissure.

The convolution which is opened to show this commissure is the "*convolution de l'ourlet*," and from the centre of it these fibres may be traced either backwards or forwards. In tracing them forwards, we find them turning over the anterior edge of the transverse commissure, and running down to those convolutions at the base, which, forming the under

and back part of the anterior lobe, are placed close to the *locus quadratus* in front of the *fissura Sylvii:* these fibres do not, however, form merely a narrow band, but an extended plane, the exact width of which cannot be defined, as its constituent fibres are in contact with the internal surface of all that part of the hemispherical ganglion which is to the outer side of the longitudinal fissure. The posterior fibres run backwards in the same manner in which the anterior run forwards, terminating in like manner in the convolutions at the under part of the hemispheres, running across the fissura Sylvii to the *locus quadratus*, where we traced the anterior. No one, I think, can trace this longitudinal commissure without acknowledging the justice of Spurzheim's observation, when after describing and reasoning on the composition of the fornix, and the apparatuses of communication in the brains of the lower animals, he says, "Thus, the especial pains which nature has taken to establish communications between cerebral parts cannot be overlooked, and it is this arrangement which enables us to understand the mutual influence of their functions respectively." Nevertheless, it is rather extraordinary that he should make no mention of the fibres above described as constituting the superior longitudinal commissure.

The lateral ventricle must next be opened, as directed at page 165. The student will again observe a structure, already briefly noticed, namely, the fornix. In pursuing the dissection of this commissure, where we have not more than one brain at our command, a difficulty arises from its lying over and concealing from view the transverse commissures which remain to be studied. This obliges us to divide it and turn it back, in order that the others may be seen; as this proceeding interferes with that perfect and minute dissection of the inferior longitudinal commissure, which can only be accomplished on a brain almost entirely devoted to it, a drawing of the fornix has been introduced in fig. 101, with the view of assisting the student to a knowledge of its complicated relations. The longitudinal commissure must now be divided in the middle, just opposite the divided end of the transverse commissure, but not removed, as we must return to the study of it; this being done, the posterior portion must be turned back, when the optic thalami on both sides may be distinctly brought into view with a fissure of some depth between them (*third ventricle*). See fig. 78.

Commissura Mollis.—Crossing the centre of this median fissure, the so called third ventricle, is the *commissura mollis*, consisting almost entirely of cineritious neurine. It connects the two thalami together. This corresponds with the gray matter, which, crossing the mesial line in the spinal cord, connects the two sides of the spinal cord together (see fig. 100, *c m*).

Pineal Commissure.—Running from before backwards along the inner edge of the thalami a white line may be seen formed by a collection of medullary fibres, which are connected to the pineal gland in the mesial line; these, through the intervention of that body, form the *pineal commissure* before mentioned (see figs. 78, 100).

Posterior Commissure.—The pineal commissure may now be divided; beneath it, and just anterior to the optic tubercles, a narrow band of

medullary neurine will be perceived; this is the *posterior commissure;* its fibres may be traced in the thalami on each side (fig. 100, *p c*).

Anterior Commissure.—The whole extent of this commissure cannot be perfectly seen in this stage of the dissection; but if the student direct his attention to the anterior boundary of the fissure called the third ventricle, he will see two rounded cords, which are called the anterior pillars of the fornix, the nature of which will be explained hereafter. Between these two cords a transverse commissure may be observed: this is the anterior commissure; and the only portion of it brought into view is that which runs across the small fissure left between the anterior pillars of the longitudinal commissure; its dissection will be most conveniently conducted at the base of the brain, where it will be found (having been already exposed in the dissection of the passage of the motory tract through the anterior cerebral ganglion of the cord, see fig. 91,) to be about three lines in width, and commencing in the middle of the hemispheres to pass through the substance of the corpus striatum or anterior cerebral ganglion, apparently receiving additional fibres from the cineritious neurine of the most external portion of this ganglion; near to the internal edge of the ganglion, however, the anterior commissure becomes quite distinct from it, and crosses over to the corresponding ganglion of the opposite side, in front of the anterior pillars of the longitudinal commissure. From the outer part of this commissure some fibres may be traced to the olfactoy nerves; these were first discovered by Spurzheim, in 1821, and are mentioned in his thesis entitled "Encephalotomie." The portion running to the olfactory nerve forms an arc the convexity of which is turned backwards, the concavity forwards.*

Pons Varolii—Transverse Commissure of the Cerebellum.—This is the last of the transverse commissures to be dissected; the appearance which it presents will be already familiar to the student, as he has traced the fibres of the spinal cord through its centre. The fibres of which it consists running from one lateral lobe of the cerebellum to the other, can be seen on the surface without dissection, and these are sufficient to establish its commissural character. But if we make a section through it we find, in addition to medullary fibres, there is a large quantity of the vesicular or cineritious neurine. The presence of this neurine gives to it a ganglionic character. This gray matter is not found in the anterior portion of the commissure, but in the posterior division, where the fibres of the cord traverse it. Burdach saw immediately the importance of this fact, and concludes that its presence has some relation to the formation of the longitudinal fibres. The connection of the commissural fibres to the cerebellum will be given in the description of this organ.

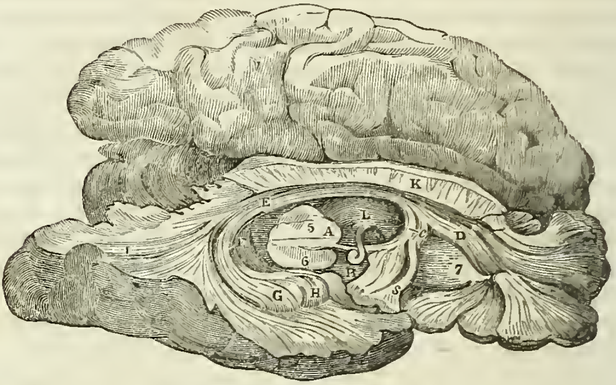
Inferior Longitudinal Commissure, or Fornix.†—The commissure to

* Chausssier and Tiedemann both regard the anterior commissure as a continuation of the cerebral crura; but with all due respect to such high authorities, I cannot agree with them; for in pursuing the dissection which has been already described, tracing the course of the anterior fibres through the corpus striatum, and giving the utmost attention to the relations of the anterior commissure, it will be found that there is no continuity of fibre between the peduncles of the brain and the anterior commissure.

† Cruveilhier, when speaking of the fornix, p. 720, says, "Shall it be considered as an anterior posterior commissure?" As a circumstance favorable to this view, I recall to mind

which we must next direct our attention is the *inferior longitudinal commissure* or *fornix* (see fig. 101), which having been divided in its centre in the course of the preceding dissection, must be replaced in its normal position.

Fig. 101.



This figure has been introduced with the view of assisting the student ln his study of the relations of the inferior longitudinal commissure or *fornix*, which may be described as commencing in the centre of the thalamus nervi optici (L), proceeding from thence to the base of the brain, where it suddenly bends upwards and forwards, forming by this turn the knuckle (B). which is called corpus albicans or mammillare. This body receives a few fibres (A) from the locus niger (6) in the crus cerebri (5), running forward from thence towards the anterior commissure, receiving fibres from the convolutions at the base of the brain, crossing and as it were kneeling upon the anterior commissure (S), and, ascending towards the great transverse commissure, forms the anterior pillar of the fornix (*c*). receiving fibres in its course from the under and front part of the anterior lobes, and thus forming the septum lucidum (D): running back from thence, passing in its course backwards over the thalamus nervi optici (L), it spreads laterally, constituting that portion which is called the body of the fornix (E): descending again at the back part of the brain it forms the descending or posterior pillar of the fornix *tænia hippocampi* (F), some of its fibres running back to be connected with the posterior lobes (I); others crossing the projection called hippocampus major (G), to be connected with the middle lobe, and others again passing over the pes hippocampi (H) to be connected with the anterior portion of the middle lobe. Thus does this commissure connect different portions of the convoluted surface of the brain together, which are inferior to the great transverse commissure, and on the same side of the mesial line. A. Fibres of the inferior longitudinal commissure, or fornix, from the locus niger. B. Corpus mammillare. C. Anterior pillars of inferior longitudinal commissure, or fornix. D. Septum lucidum. E. Body of the fornix, or centre of the commissure. F. Tænia hippocampi, or descending fibres of the inferior longitudinal commissure. G. Fibres covering the hippocampus major. H. Fibres covering the pes hippocampi. I. Fibres covering the hippocampus minor. K. Great transverse commissure divided in the mesial line. S. Posterior cerebral ganglion, or thalamus. *l.* Anterior commissure. 5. Section of the crus cerebri. 6. Locus niger. 7. Anterior cerebral ganglion, or corpus striatum, partially scraped away.

This part has not been generally described in the light of a commissure. By Vieussens it was considered simply as the under surface of the corpus callosum; but the direction of its fibres being so entirely different, that is, being longitudinal instead of transverse, it is impossible to agree with that celebrated author in this view of the relations of the fornix. The name of Fornix is derived simply from its vaulted figure, for it forms in the centre of the cerebral mass a surface which is convex superiorly and concave inferiorly, bearing, therefore, some resemblance to an arched or vaulted roof. By the German anatomists it is called the twain band. If the student will here refer to fig. 101, he will find the following description considerably elucidated.

The general form of the fornix may be described as that of a vaulted roof supported upon four pillars, which, unlike pillars in general, are bent nearly double, the anterior pair presenting their concavity forwards,

that I have seen the right half of this vault atrophied in a case of destruction of those cerebral convolutions which lie on the tentorium cord.

the posterior pair theirs backwards. Its real character, and the direction of the fibres composing it, will be ascertained by making a section of the brain, so as to obtain a side view of it; and in order to effect this, the crus cerebri on the right side should be divided by an incision just between the optic tubercles and the posterior cerebral ganglion ; and the scalpel being kept quite close to the inner side of that ganglion, the incision may be carried forward, running also on the inner side of the motory ganglion, and then cutting through the anterior lobe into the anterior fissure, as has been done in the dissection from which fig. 101 is taken. This commissure, like every other commissure, cannot, strictly speaking, be described as commencing in one part more than another; in describing it, therefore, as commencing in the crus cerebri, it must be remembered that it would be equally correct to describe it as terminating there ; but being obliged to suppose it to commence at some point, we shall speak of it as arising from the cineritious neurine, or *locus niger*, in the centre of the crus cerebri.

From the centre of the crus cerebri the fibres of the longitudinal commissure may be traced to the corpora mammillaria, at which point they are joined by a band from the interior of the thalamus, which can be most easily dissected when the brain rests on its upper surface and the base is exposed (fig. 101, B; fig. 100, *c a*), when it will be found that this little body is produced by a turn of the band coming from the interior of the thalamus; for this band, after emerging from the thalamus, first runs directly inwards, then turns suddenly forwards and forms a sort of knot, such as we can imitate exactly by means of our handkerchief or soft cloth. This arrangement is very well delineated in Langenbeck's Plates of the Brain ; it has been described and designed by Vicq d'Azyr. Reil was also aware of its existence. Cruveilhier states that he has traced it to a connection with the tænia semicircularis. Prof. Erle considers that he has traced fibres from the optic nerve through the thalamus into this band, and continuous with the fornix in the course now described.

From the corpora mammillaria the fibres are collected, so as to form two rounded cords; the course of these is first forwards, then upwards, and afterwards backwards, thus forming a semicircle, the concavity of which facing backwards used to be called the anterior pillars of the fornix, and is free and unattached, whilst the anterior or convex edge receives fibres from the anterior lobes and beneath the great transverse commissure,* by which means a thin delicate septum is formed, called the *septum lucidum*.†

These pillars also receive two sets of fibres anteriorly; first, from a white band which has already heen under the notice of the student—the *tænia semicircularis*—running in a groove between the thalamus and corpus striatum; the *tænia semicircularis* commences (see fig. 100, *s*)

* I believe that I was the first to describe the septum lucidum as consisting of longitudinal fibres, and thus forming a portion of the longitudinal commissure.

† Rolando describes the septum lucidum as a folding in of the fibres of the hemispheres from the corpus callosum. The direction of its component fibres convinces me, however, that such cannot be a true view of its construction, and the fornix as a whole he views as merely a portion of the corpus callosum.

from the middle lobe in the descending cornu of the lateral ventricle, and is continued through the body of the lateral ventricle into the anterior columns of the fornix: secondly, a set which are described further on as the peduncles of the pineal gland or the pineal commissure, beneath the last (fig. 100, o). The longitudinal commissure in its passage backwards under the great commissure (corpus callosum), to which it is attached, spreads laterally, and at first is nearly of the width of half an inch; while tracing its fibres in this portion of its course, two projections are observed, which have received the names of hippocampus major, and hippocampus minor; they are situated in the descending and posterior cornua of the lateral ventricles.

"The hippocampus," says Wenzel, (p. 134, *op. cit.*,) "from the time of Arantius, who first described them (Observations Anatomicæ, Venetiis 1587, 4 Observat. 3, page 45), to that of Haller, was considered as a continuation of the fornix, or, in the words of Haller, "pro fornicis ipsius cruribus." Haller referred them to the corpus callosum, considering them as continuous with its structure, saying (Commentaria ad prælectiones academicas, H. Boerhaave, tome ii., Taurino 1743,-4, p. 509), "Nobis imprimis tæniæ continuæ videntur fornici tubera fornix ad tantum horum corporum molem, neque posteriores pedes hippocampi facere possit."

Gunz (Prolusio, Observationes anatomicas de cerebri continens altera. Leipsiæ 1750, 4) points out very decidedly that the corpus fimbriatum, as it is usually called, is the true pillar of the fornix.

In this division of our subject it will, I think, be advisable to inquire into the real character of these hippocampi, and the relation they bear to other parts of the brain.

If the hippocampus major be examined carefully in a brain that has been thoroughly hardened in spirits of wine, it will be found to consist of cineritious neurine covered by a thin layer of medullary fibres. The cineritious neurine is on the same plane, and continuous with the convolutions at the base of the brain, and is in reality a true convolution; the medullary fibres come from the under part of the cerebrum in various directions, and being collected at the inner edge of this body, form what have usually been called the posterior pillars of the fornix, or the tænia hippocampi, but which we must regard as the posterior descending extremity of the inferior longitudinal commissure.

The cineritious neurine over which these fibres of the longitudinal commissure run from before backwards, and from below upwards, is, in fact, nothing more than a continuation of that neurine which constitutes a portion of the convoluted surface of the brain, neither more nor less, therefore, than a part of the hemispherical ganglion, but in this situation covered by the inferior fibres of the longitudinal commissure. Its large size in some of the lower animals, especially those in whom the olfactory ganglia are much developed, has gained for it by some anatomists the title of hippocampal lobe; and though clearly a continuous portion of the cortical substance of the brain, in all probability it has its peculiar and individual office to perform in relation to the sense of smell.

Wenzel was aware of its real character, justly observing, (p. 141,) "Hippocampus ergo, manifesti nihil aliud est, nisi continuatio superficii

cerebri intro flexa, sive in unam lateralium ventriculorum partem; sive hippocampus nil est nisi unius gyrorum in superficii cerebri sitorum in interius cerebri prolongatio."

The hippocampus minor is in some respects analogous to the hippocampus major; for it is formed by the projection of one of the fissures dividing the convolutions at the inner side of the posterior lobe, where it is covered by the posterior fibres of the longitudinal commissure. It differs from the hippocampus major in this respect, that the projection is caused by the *central* surface of the convolutions, and not by the *peripheral* surface, as is the case in the hippocampus major.

This account of the fibres which enter into the composition of the inferior longitudinal commissure will prove to the student that this structure connects the cineritious neurine or locus niger of the crura cerebri and the thalami nervorum opticorum with the convolutions of the hemispheres, as well as most of the convolutions of the same hemisphere, together, and is in this respect distinguished from the great transverse commissure, whose office is to connect the two opposite hemispheres together. It must be regarded, therefore, as an apparatus of union between different points of the same hemispherical ganglia. The presence of these two longitudinal commissures connecting together different parts of this extensive layer of vesicular neurine may be regarded as offering presumptive evidence in favor of the opinion, that this ganglion, though *anatomically* but one centre, *physiologically* consists of many, which is the fundamental principle of phrenology.

There is another portion of cineritious neurine which I am compelled to mention in consequence of its being uniformly described in all descriptions of the brain under the silly name of *corpus denticulatum;* I say silly name, because it would have been equally wise to have given a particular appellation to every square inch of the convoluted surface as to this portion, which is partly covered by the posterior pillar of the longitudinal commissure. The *corpus denticulatum* is neither more nor less than a portion of the hemispherical ganglion, which, being brought into view according to the old method of dissecting the brain by cutting through the posterior pillar of the fornix, appeared to be a distinct part deserving an appropriate title.

Inter-cerebral Commissure, or Cerebral-cerebello Commissure.—The remaining commissure which demands our attention consists of medullary fibres connecting the two great cerebral masses, the cerebrum and the cerebellum, together, as well also as the optic tubercles and the cerebellum; these fibres have been briefly noticed before under the name of the *inter-cerebral commissure*, consisting of fibres thick and strong on each side, but extremely thin and delicate in the centre; the fibres are arranged longitudinally in both situations (fig. 77, fig. 102, I & c).

The constituent fibres of this commissure are not so simply arranged as we might in the first instance be inclined to suspect. To me they appear to be divisible into three sets; and as they are all collected together at the point where they enter the cerebellum, we shall describe them from that point forwards.

1st. The most *superior*, those in fact which form the surface of the

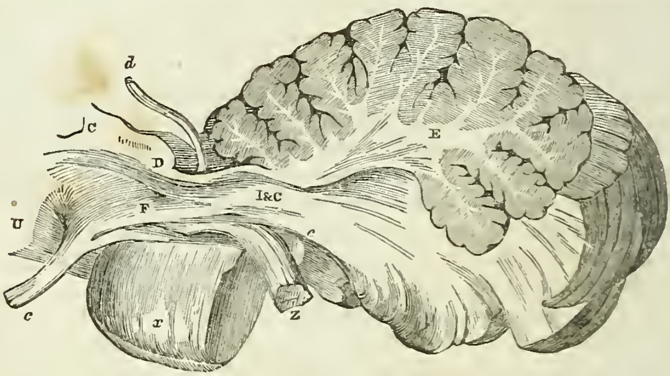
processus è cerebello ad testes, and the valve of Vieussens, may be traced distinctly to the optic tubercles.

2dly. The *external;* these form the external surface of the processus è cerebello ad testes, and may be traced to the side of the optic tubercles, and thence to the optic thalami, and as far as I can discover, though I cannot speak decidedly, through that ganglion to the hemispheres.

3dly. The third and last set are the deep or descending fibres: these may be seen by first dividing the cerebellum into two halves, then dividing close to the cerebellum that portion of the pons Varolii called the crus cerebelli, and the corpus restiforme. If the cerebellum be now raised, tearing up the inter-cerebral commissure, it will be found that some of its fibres descend, and in so doing interlace with the ascending fibres of the sensory tract: these descending fibres may be traced through the locus niger of the crus cerebri till they become continuous with the motor tract, and also with the portion of the longitudinal commissure or fornix which takes its origin at that point. See fig. 107, I & C, representing the relation of the fifth pair of nerves to this commissure.

A perpendicular incision having been made through the centre of the cerebellum, the course of this commissure into its interior may be next demonstrated, and at the same time that beautiful appearance, which from its resemblance to the branches of a tree is called the *arbor vitæ*, observed distinctly exposed.

Fig. 102.



C. Anterior optic tubercle. D. Posterior ditto. E. Cerebellum divided, showing the arbor vitæ. F. The descending fibres of the inter-cerebral commissure. I & C. Another portion of the same commissure. U. Crus cerebri. X. Commissure of the cerebellum divided. Z. Portion of the olivary tract and restiform body, divided from the cerebellum, and raised so as to show the motor origin of the fifth pair of nerves (*e*). *c*. Third pair of nerves. *d*. Fourth pair of nerves. *e*. Motor origin of the fifth.

On reviewing what has been said on the commissures it will be found that they may be arranged under two heads; the transverse and longitudinal.

The *transverse commissures*, six in number.

1. The great transverse commissure of the hemispheres, or the corpus callosum.
2. The pineal commissure.

3. The posterior commissure, or commissure of the posterior cerebral ganglia, or thalami nervorum opticorum.
4. The soft commissure, or commissure also of the posterior cerebral ganglia.
5. The anterior commissure, or commissure of the anterior cerebral ganglia or corpora striata.
6. The commissure of the cerebellum, or pons Varolii.

The *longitudinal commissures*, four in number.

1. The superior longitudinal commissure.
2. The inferior longitudinal commissure, or fornix.
3. The inter-cerebral commissure, or processus è cerebello ad testes, with the valve of Vieussens.
4. The olivary commissure.

The Cerebellum.—This portion of the encephalon is situated in the posterior division of the skull beneath the cerebrum. In the human subject it is more completely overlapped by the cerebrum than in any other animal.

The portion of the skull in which it is contained is bounded *superiorly* by the tentorium, by which it is separated from the posterior lobes of the cerebrum, *posteriorly* and *inferiorly* by the occipital bones, *laterally* and *anteriorly* by the temporal and parietal bones.

The superior surface of the cerebellum is almost flat, but is not placed quite horizontally, rising anteriorly where it comes in contact with the optic tubercles (fig. 105).

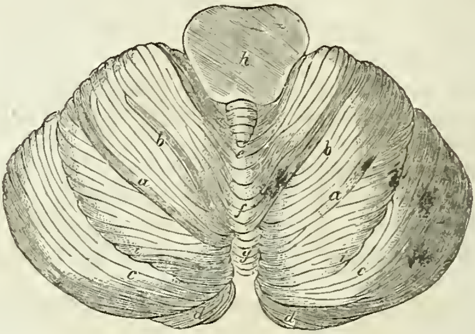
The relative position of the cerebellum to the cerebrum and the occipital bone, and thus to its position in the neck, is very clearly exhibited in fig. 71, E, and should be reflected upon by the student before he removes the cerebellum from the cerebrum, in order to study its external configuration and dissect the course of its fibres. For he cannot clearly observe each surface of the cerebellum unless it is removed with the medulla oblongata from the cerebrum by cutting through the crura cerebri.

The pia mater and arachnoid must next be carefully and entirely dissected from every portion of it, as well as from the pons Varolii and medulla oblongata.* This having been done, and its superior face ob-

* The following directions are given by Reil, for the preparation of the cerebellum. "The cerebellum of a male should be selected, and of one who may have died in early manhood of some chronic disease; it should be in as fresh a state as possible; the brains of those who have died of typhus lose their consistence too soon for this purpose, and where inflammation of the brain has existed, the membranes are not easily separable. The cerebellum may be detached by dividing the crura cérebri above, and the medulla oblongata below; it should then be placed in a basin under water, and the membranes removed with the forceps; the membranes are prevented from drying, and the blood exudes more freely, when the part is thus immersed in water. The denuded cerebrum is now to be placed in a vessel, and to be twice washed by the effusion of brandy, which may be suffered to remain on it some minutes; afterwards alcohol is to be substituted, in which it should stand twelve hours; when, in this way, the surface appears somewhat hardened, the membrane is to be removed from the deeper furrows, in order that the spirit may everywhere penetrate the mass; spirit is then again to be poured over the preparation, which may stand a day or two: finally the alcohol is to be renewed, and the vessel closed and set by for two or three months, till the part has acquired a grayish color, and is thoroughly hardened. It is right, during this time, to turn the preparation occasionally, and to contrive that every surface is freely bathed in the spirit."

served, it will be found to consist of innumerable laminæ, separated by furrows which take a curved direction, the concavity forwards, and convexity backwards. These fissures hetween them vary in depth from a line to half an inch, increasing from before backwards.

Fig. 103.



Superior surface of the cerebellum. *a a.* Lateral lobes. *b.* Lobulus quadratus, or square lobe. *c* Superior semilunar lobe. *d.* Internal part of the inferior semilunar lobe. *e* & *f.* Superior vermiform process. *g.* Commencement of the valley. *h.* Pons Varolii. *i.* Superior fossa of the cerebellum.

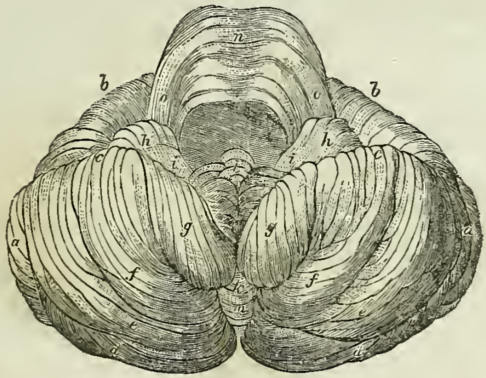
The deeper furrows form the boundaries of the lobes, the shallower ones of the lobules: this arrangement is best seen by a vertical section (fig. 102). The central portion of this surface being elevated, has been described by some authors as a distinct process, the *superior vermiform process* (103, *e*). This portion of the cerebellum has been described by Reil as a commissure, but it does not appear to me to be an apparatus of union, but rather a centre of power placed in the mesial line, and connected laterally with the two hemispheres, perfectly analogous to the cerebellum of all animals below the Mammalia. Reil, himself, states that in the brain of the hare there is little more than a vermiform process. Indeed a mere section of it ought to be sufficient to convince us that it is no true commissure. Comparative anatomy has shown us that this, the central lobe, is the fundamental portion of the cerebellum. The laminæ of it curve forwards, while those of the lateral lobes on each side curve backwards.

Viewing the superior surface of the cerebellum, we observe the lateral lobes are again subdivided (103) by a deep fissure, into a lobe of a square shape (*b*), situated anteriorly; and a semicircular-shaped lobe (*c*) on the posterior margin. The lobulus quadratus is bounded by the fissure of the anterior margin, the semilunar fissure of Reil, in which is situated the pons Varolii.

At the posterior extremity of the superior surface a deep and wide notch also occupying the mesial line may be observed. This notch, called by Reil the purse-like fissure, divides the cerebellum into two lateral lobes or hemispheres, as they are sometimes called, as will be more distinctly seen by reversing the position of the cerebellum. Separating the under from the upper surface, there is a very deep horizontal fissure (fig. 104, *c*). Looking at the under surface of the cerebellum

and medulla oblongata when they are removed together from the rest of the brain, we observe first the medulla oblongata lying in this mesial furrow, the *valley*. Raising the medulla and turning it forwards, we next observe another worm-like process, the *processus vermiformis infe-*

Fig. 104.



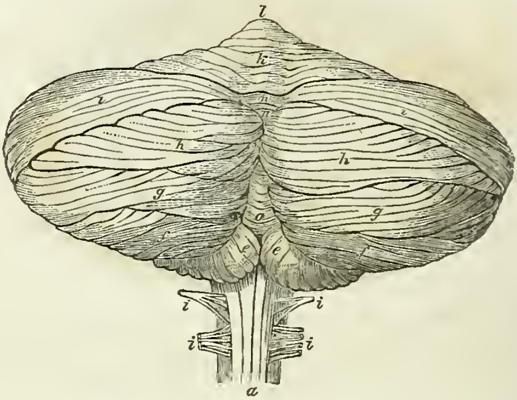
Inferior surface of the cerebellum. The medulla oblongata is cut away close to the pons Varolii. *a a.* Lateral lobes. *b.* Anterior and external part of the semilunar and square lobes. *c.* Great horizontal fissure. *d.* Inferior semilunar lobe. *e.* Slender lobe. *f.* Biventral lobe. *g.* Tonsilla lobes, or amygdala. *h.* Flocculus. *i.* Its white substance. *k.* The spigot, or inferior vermiform process, almost covered by the tonsils, or amygdala. *l.* Nodules. *m.* Pyramid. *n.* Pons Varolii, or commissure of the cerebellum. *o o.* Crura cerebelli.

rior, connecting the two lateral lobes, and partly filling up the valley. This vermiform process is laminated in the same manner as the lateral lobes; it is divided by Reil into three portions; the posterior he calls the pyramid (fig. 104, *m*), the middle, the spigot; and the anterior, the nodule (fig. 104, *l*). The fissures in this, the under surface, are much deeper than in the upper. Their direction at the anterior part, instead of being from side to side, is from before backwards, cutting so deeply into its substance that Reil has described the intermediate portions as distinct lobes. Each lateral lobe or hemisphere of the cerebellum has five lobes; the most anterior and inferior of these portions is the smallest; it is more separated than the rest, and stands out from the inferior edge of the pons Varolii close to the corpus restiforme, like a cauliflower on a stalk. This first lobe is called, by Reil, the *flock* (fig. 104, *h*), and stated to be absent in the lower animals. Immediately behind the flock, lying in contact with the restiform bodies of the medulla oblongata, is the tonsil-shaped lobe, or *amygdala* of Reil (*g*); the next division in succession as we pass backwards is, Thirdly. The biventral lobes (fig. 104, *e*), which lie between the slender lobes and the amygdala. Fourthly. The slender lobes (*e*). Fifthly. The under and posterior semilunar lobes (*d*).

A view of the posterior surface is also very instructive, as exhibiting the above-mentioned lobes from a different point of sight (fig. 105). From this general view of its configuration the student must proceed to the more difficult and important question of its internal structure. First, the arrangement of its gray neurine which forms its ganglionic portion.

The arrangement of the gray neurine in the cerebellum is beautifully simple, for, with one exception, it is entirely on the surface. This layer, like the hemispherical ganglia, or the cortical substance of the hemispheres, is of immense extent, requiring in the same manner to be folded up in order to pack it into the small space devoted to its reception. The term *laminated ganglion of the cerebellum* might be advantageously employed to designate it.

Fig. 105.



Posterior surface of the cerebellum and spinal cord. *a.* Spinal cord. *e.* Amygdala. *f.* Biventral lobe. *g.* Slender lobe. *h.* Inferior semilunar lobe. *i.* Superior semilunar lobe. *k.* Square lobe. *l & m.* Superior vermiform process. *n.* Inferior ditto. *o.* Pyramid. *i i.* Posterior roots of the cervical nerves.

Its extent and relation to the fibrous neurine is best seen by perpendicular and horizontal sections, as directed further on.

The only gray neurine in the *interior* of the cerebellum is deposited a little on each side of the mesial line, very near to the centre. It is a curious waving surface, presenting both in a perpendicular and horizontal section a denticulated appearance, very like that in the interior of the corpus olivare, only rather more than twice its extent (fig. 92).

This body, long known as *corpus rhomboidum*, *corpus dentatum*, *kernel of the cerebellum*, &c., was denominated by Spurzheim the ganglion of the cerebellum.

"Vicq d'Azyr," says this author (see p. 121), "believed that the ganglion of the cerebellum was only to be found in the human kind. But in 1808, conjointly with Dr. Gall, I showed that it exists in the Mammalia generally; and I now add, that it is very distinct in birds. Whenever the cerebellum is somewhat considerable, it may always be demonstrated; its small size and pale color were probably the causes of its existence being overlooked. But it is matter of prime importance not to confound the forms assumed, and the lighter or deeper shades of color possessed by the pulpy substance, with its necessary existence."

I think that the better title, one more in accordance with the principle of nomenclature already advocated, would be Ganglion dentiforme.

Reil (p. 33, Mayo's Physiol. Com.) compares the laminated arrangement of the medullary and cineritious matter of the cerebellum to the

"plates of a voltaic pile." I do not see the correctness of this simile. Indeed, this arrangement seems rather a necessary part of that admirable contrivance which we observed carried out in the hemispheres of the cerebrum, for obtaining an extensive surface of gray neurine placed upon and in close connection with a corresponding amount of white fibres; inasmuch as the gray neurine being supposed to generate power, requires an adequate supply of conducting instruments in the white fibres for the exportation of its power, or the importation of a stimulus to its production.

The student may first study the white fibres of the cerebellum merely anatomically, reserving for future consideration the physiological question, which of them belong to the motor, sensory, or commissural tracts. Speaking metaphorically, and without reference to their offices or the course of nervous power, they are derived from six sources, three on each side.

The collected bundles from which we are supposing them to emanate external to the cerebellum, are described as the peduncles of the cerebellum, and named from their position, *superior*, *inferior*, and *middle* peduncles. These terms, though unphysiological, it is, perhaps, convenient to retain.

The great transverse commissure of the cerebellum, or pons Varolii, had better first engage the student's attention. In his previous dissections he has observed how the anterior and posterior columns of the cord traverse its central portion. Now he must follow out the lateral portions, *crura cerebelli* of old authors, which plunge into the substance of the cerebellum. Let him reverse its position and place the pons Varolii upon its under surface, and raise with the fingers all those laminæ of the cerebellum which overlap it as it enters this ganglion. And by taking a pinch, if I may so say, of these laminæ, and tearing them upwards and inwards, the course of the fibres of this the middle peduncle of the cerebellum will be seen spreading in all directions, and running into each separate lamina both of the superior and inferior vermiform process and the lateral lobes. The same mode of dissection pursued at the under surface will expose them, running equally to all parts of the cerebellum, including the inferior vermiform process (fig. 104).

Indeed, if there is one point in the anatomy of the cerebellum on which I feel more certain than another, it is the fact that the fibres of the pons Varolii are in connection with the whole of the laminated ganglion or cineritious surface of the cerebellum.

They do not appear so intimately connected with the dentiform ganglion as those of the superior peduncle, but I am not able to say that they do not pass through it.

The inferior peduncles are the *corpora restiformia*, or processus è cerebello ad medullam oblongatam, consisting, as before stated, of motor and sensory fibres. The best mode of following them to their destination is to raise the auditory nerve (fig. 108) just at the lower edge of the pons Varolii, and by turning it down carefully with a probe its two roots which embrace the restiform body will be seen, and that body distinctly exposed just as it plunges into the cerebellum, where it will be found to pass upwards, beneath, and to the inner side of the crus cerebelli or

lateral portion of the pons Varolii, from which it may easily be separated by a probe.

I prefer a probe, or any narrow blunt instrument, for dissecting the brain, as less liable to deceive you with regard to the existence and direction of fibres.

The student should next divide the whole of the transverse commissure or crus cerebelli, carefully avoiding the inferior peduncle, or restiform body; and tearing this commissure in the same direction as before, upwards and inwards, the fibres of the restiform body will be seen running to both the inferior and superior vermiform process and the posterior laminæ of the lateral lobes. But here, as in the case of the superior peduncle, I cannot state positively the extent of the connections of the fibres of the restiform bodies; but my belief is that they do not pass laterally, or reach the surface of the lateral lobes.

And it is most probable that such is the arrangement, considering the fact that the lateral lobes of the cerebellum are deficient in those animals in whom the pons Varolii is wanting, and extremely small in all animals except in man, in whom alone the pons Varolii attains any size at all.

The superior peduncle of the cerebellum has been already referred to as the inter-cerebral commissure, or processus è cerebello ad testes. Its component fibres are, however, twofold, as before stated: one portion of them truly commissural, connecting the cerebrum and cerebellum together; the other is derived from the motor tract. The fibres of this, the superior peduncle, may be traced into the substance of the cerebellum by first raising those laminæ of its superior vermiform process, which, overlapping this body, are in apposition to the optic tubercles. Next tearing up carefully one lamina after another, the fibres of this peduncle will be seen to pass in the leaflets of this vermiform process.

To the outer side of this process they are found running through the ganglion dentiform of the cerebellum to the posterior laminæ, and I have not yet been able, by the most careful dissections, to satisfy myself that these fibres spread into the lateral lobes so as to reach the lateral lamina. In this portion of their course they are overlaid by that thick layer of fibres from the pons Varolii which sweep round from the outer side of the cerebellum to the superior vermiform process. The remaining fibres of this peduncle pass to the inferior vermiform process; these may be easily traced after making a perpendicular section through the centre of the cerebellum.

Those fibres of this peduncle, which are apparently derived from the motor tract, will be most clearly demonstrated by dividing the cerebellum into two halves, then dividing close to the cerebellum that portion of the pons Varolii called the crus cerebelli, and the corpus restiforme. If the cerebellum be now raised, tearing up the inter-cerebral commissure, it will be found that some of its fibres descend, and in so doing interlace with the ascending fibres of the sensory tract; these descending fibres may be traced through the locus niger of the crus cerebri till they become continuous with the motor tract.

The physiological analysis of the *cerebellar* fibres is simple: First,

there are transverse commissural fibres in the shape of the pons Varolii, or great transverse commissure, connecting the whole corresponding surface of the ganglion of the cerebellic hemispheres. Secondly, longitudinal commissural fibres, the inter-cerebral commissure connecting the cerebrum and cerebellum. Thirdly, motor fibres passing from the cerebrum in common with the rest of the motor tract through the corpus striatum, or crus cerebri, entering into the composition of the superior peduncle and terminating in the superior and inferior vermiform processes. Fourthly, motor fibres emanating from the superior and inferior vermiform processes, entering into the composition of the restiform bodies, and joining the anterior portion of the cord, as the cerebellic fibres of the anterior columns. Fifthly, and lastly, sensory fibres from the posterior columns of the cord, forming likewise a portion of the restiform bodies, and terminating in the two vermiform processes.

Let the student now call to mind the simple form in which the cerebellum was first presented to his notice. In the carp, he saw it as a mere rounded point; in the whiting, a narrow leaflet or tongue; in the skate, advanced so as to form two larger or more distinct leaflets; in the tortoise, much larger, and hollowed out internally; and in the bird, so much further advanced as to assume a true laminated character.

"The cerebellum of the bird," (says Reil, p. 205, whose account of the development of this organ I have followed almost literally, and which will be found peculiarly interesting to the student after he has thoroughly mastered its anatomy in the human subject,) "represents indeed a vermiform process alone, and wants the lateral parts, which are superadded in animals more nearly allied to human beings in their anatomical construction, possessing in their place little germs or shoots scarcely discernible.

"The successive additions, which may be traced to this simple form of a cerebellum, are of a similar structure with the elementary part: and those additions which adhere with the primitive portion by *medullary* substance alone, being otherwise separate and distinct, are termed offsets (Ansätze); those which are connected both by medullary and cortical substance are termed wings (Flügeln) of the vermiform process. Among the lower animals, there are but few and simple offsets; higher in the scale, these become more numerous; the vermiform process extends itself laterally and receives wings, and in proportion as the wings are developed, the offsets diminish. The first improvement in the cerebellum takes place at its anterior and upper surface; while on its under surface the parts remain contracted and sunken. The vermiform processes predominate even in quadrupeds, in length, breadth, and depth; the fore part only of the cerebellum possesses distinct wings; laterally and behind, there are only offsets. In proportion as the fabric improves, the offsets are changed into wings, till at length in human beings the hemispheres are completed; and with the exception of the flocks, the offsets have wholly disappeared. All the parts are now brought together in compact order: the vermiform processes, with their wings, constitute one whole, between the parts of which the freest communication seems to exist, which the employment of offsets would interrupt.

"In the brain of the hare there is little more than a vermiform process: there are but few wings, and these slight and short: the lateral offsets are small. In the brain of the sheep the central lobe is large, firm and broad, but has neither wings nor offsets: the anterior velum is somewhat depressed upon the fourth ventricle. The next lobe in order is broad, of some length and depth, but has laterally short projections, not equal in their breadth to half the length of the vermiform process; these, however, may be viewed as wings. In the third lobe the organ is contracted, and has longer and larger wings; there follow, upon the under surface, a pyramid, spigot, and nodule, which have no wings, but a large bundle of lateral offsets; between the wings and offsets the peduncles of the annular protuberance emerge, and mark the place of the horizontal fissure. The whole cerebellum has a globular form, which results from the projection of the vermiform processes. The latter stand more or less vertically over the medulla oblongata, and have an anterior and a posterior surface, which correspond with the superior and inferior surfaces of the same parts in the human brain. The lateral offsets in the higher animals are more and more driven from the fore to the back part of the cerebellum, until at length, in the human brain, they are exchanged for the lobes of the inferior surface, which unite with the inferior vermiform process. The whole cerebellum seems, indeed, pressed backwards, as its parts become more complex; so that the central lobe continually emerges more and more from between the peduncles of the tubercula quadrigemina, and in the human brain lies fairly behind these bodies, the common anterior stem being directed upwards, and the posterior horizontally. In the brain of the ox the central lobe is large, and without wings; the remaining lobes of the anterior surface are of inconsiderable dimensions: on the posterior surface, the pyramid, spigot, and nodule are barely separable; they are without wings, and have scarcely offsets. Lastly, in the brain of the horse the central lobe is large, and without wings, but of less size than in the ox, and more compressed from above downwards. The next lobes of the vermiform process have anteriorly larger and longer wings, which are bent forwards, contracted in their middle, and at their ends have a club-like thickening. The upper and posterior lobe is distinct; but the under and posterior, the slender, the biventral, and almond-like lobes, are wanting, and in their stead a large bundle of irregular offsets is found on either side of the pyramid, the spigot, and the nodule.

"Thus the enlargement of the cerebellum proceeds from the central primary portion; to which new processes, as wings or offsets, are continually added, in proportion as the scale of its improvement rises. In quadrupeds, and even in the human brain, traces of the simplest type of a cerebellum are to be seen in the central lobe, illustrating further the principle on which its improvement proceeds. The furrow between this lobe and the lateral processes connected with it is so deep, as to leave it doubtful whether the latter are properly wings or offsets.

"In the human brain the wings form the principal part of the cerebellum, viz. the hemispheres. On the upper surface these are immediately prolonged from the vermiform process; on the under surface they seem incomplete, being separated by a deep furrow from the inferior vermi-

form process on either side. It is remarkable that the human cerebellum, the most complex in its structure of any, should yet exhibit a resemblance of the clearest kind to the primitive and elementary form. When the human cerebellum is placed with its usually horizontal axis in a vertical direction, it may be rigorously compared with the cerebellum of birds: what in the latter case is a single lamina, is here subdivided, and has become arborescent; in the one case single leaves; in the other, lobes, lobules, and finally leaves, are raised around the nucleus, forming a dense investment to it, from under which the peduncles project on each side, like the fin-like feet from under the shell of the turtle.

"In proportion as the lateral parts increase in the shape of offsets or wings, the vermiform processes become smaller, as if compressed towards the centre. This circumstance is most apparent in the human brain: the vermiform processes are there comparatively diminutive in every dimension, in length, breadth, and depth: before them spring out the horns of the semilunar fissure, behind them the projecting margin of the purse-like fissure: within the latter, and at the place of the spigot and nodule, the inferior vermiform process is scarcely a few lines in breadth. In animals the vermiform processes overtop the lateral portions; in man the upper surface of the general commissure is only on a level with the hemispheres, while below it is contracted and shrunken to the bottom of the valley. This compression of the general commissure on all sides in the human brain, accounts for the difference observable in its structure as compared with that of the hemispheres; a difference which is not found in the brains of quadrupeds. In its texture this part in the human brain is softer, and its membrane firmer and more vascular than is the case in the hemispheres. The medullary matter is here again in thinner layers than in the hemispheres; thinly spread out in the anterior velum, it forms a thicker mass at the meeting of the vertical and horizontal process, where the nucleus of the general commissure begins: in the former process it exists in greater quantity than in the latter, and finally it forms an extremely thin layer in the posterior velum. In the anterior fissure the general commissure has its greatest breadth, becoming narrower as it passes towards the purse-like fissure: in the single commissure, where it has shrunk to a single lamina, and in the short commissure, it continues still narrow; it becomes broader again at the pyramid, and finally tapers to a point in the spigot and nodule. On either side of the superior vermiform process there are furrows of greater or less depth, at which the laminæ are thinner, and indented, and their direction altered; so that whereas the convex margin of the laminæ of the hemispheres is directed backwards, that of the laminæ of the superior vermiform process looks forward. In these furrows, by which the lateral limits of the superior vermiform process are defined, blood-vessels are lodged; these furrows are continued along the valley, where they become deeper.

"Looking generally at the vermiform processes, we observe that they are composed of corresponding portions on either side of the median plane, that there is no material difference in the structure of the upper and under portions, and thus that the whole is one homogeneous organ. We may observe further, that whereas in birds these parts con-

stitute the whole of the cerebellum, and in quadrupeds the principal portion, in human beings, where their relative bulk is trifling, compared with that of the hemispheres, they are, on the one hand, parts of the same composition and nature with the latter, and on the other may be considered as the general commissure, by which the lateral portions are intimately united."

Tuber Cinereum, Infundibulum, and Pituitary Gland.—The only parts of the brain which now remain to be noticed, are situated at its base, namely, the tuber cinereum, infundibulum, and pituitary gland. The tuber cinereum derives its names from the cineritious neurine of which it consists, and which entitles it to be classed among the *ganglia.* From the circumstance of the optic nerve sending some filaments into its substance, and the longitudinal commissure deriving several from it, I am inclined to view it as an instrument of power connected in some way or other with the phenomena of vision. Its general form has been already noticed in the description of the base of the brain. The infundibulum, or pituitary process, is a funnel-shaped tube, deriving its name from its shape; it passes down from the tuber cinereum to the pituitary body. It is hollow, and consists principally of cineritious neurine, but internally some white fibres may be seen descending in a striated manner from the mesial surfaces of the thalami. They are best seen by means of a glass, magnifying about ten diameters. I am inclined to regard this process as a medium of nervous communication or commissure between the pituitary body and the thalami. The pituitary body, or gland, is situated, like the semilunar ganglion of the fifth pair of nerves, external to the dura mater. It occupies the whole of the sella turcica of the sphenoid bone. It weighs, with the infundibulum, about eight grains. It consists of two lobes, an anterior and posterior. The anterior, which is about twice the size of the posterior, lodges the latter in a hollow on its posterior edge.

The structure of this body is similar to the cineritious neurine of the brain; it is vesicular, made up of large nucleated cells, surrounded by a granular matter imbedded in a white fibrous tissue. This fibrous tissue accompanies the blood-vessels, which are found in it in great numbers. Its substance is soft, but not so soft as the cerebral matter, and when pressed between the fingers, is reduced to a grayish pulp, like the substance of an absorbent gland in an early stage of suppuration.

It is larger in the infant than in the adult, and more developed in some of the Vertebrata than in man. We have already observed its great size in fish. Some anatomists have supposed that the pituitary body is the cerebral ganglion of the sympathetic nerve; and to me this appears a very probable hypothesis.

Dr. Todd does not consider it a ganglion, but says, "It may with more propriety be classed with the glands without efferent ducts; and from its numerous vessels and close relation to part of the venous system within the cranium, it may be connected with the process of absorption or removal of the effete particles of the brain."

Recapitulation.—The description of the course and termination of the various tracts of medullary neurine which, with their ganglia, constitute the brain or encephalon, being now concluded, it will, I think, be useful

to take a general review of the subject, by a recapitulation of what has been stated in detail separately; and we will reverse the order of our observations, proceeding from above downwards instead of from below upwards.

In the first place, we have an extensive surface of cineritious neurine, the *hemispherical ganglion*, (speaking merely of one side of the brain,) which, in the higher orders of animals, is convoluted or folded in a peculiar manner.

In apposition to the whole of the vesicular neurine of this ganglion, there are tubular fibres which radiate through it, and are encrusted by its nucleated cells.

These fibres are disposed of in four different ways; 1st, some of them, commencing from the convolutions of the anterior, middle, and posterior lobes, pass through the corpora striata, and, forming the inferior layer of the crus cerebri, pass through the pons Varolii, so as to form the anterior columns of the cord, as previously described—the *motor tract:* 2d, others commencing in the nerves of sensation, and after passing through the pons Varolii, and emerging from the substance of the thalamus, terminate in the same neurine that gave origin to the last; this is the *sensory tract:* 3d, others, passing from one side of the brain to the other, and in apposition to the internal surface of all the convolutions, are those fibres which, collected into a mass, form between the hemispheres that wide bridge, if I may so call it, the *great transverse commissure*, or *corpus callosum:* 4thly and lastly, in contact with all the convolutions are the fibres of the superior and inferior longitudinal commissures, which, connecting together those convolutions which are situated on the same side of the mesial line, or different portions of the same hemispherical ganglion, so far differ from the transverse commissure, which connects those situated on opposite sides, or the two distinct but corresponding ganglia.

The first and second set of fibres, which radiate from the external surface of the two large ganglia of the anterior and posterior columns, as from a common centre, forming, however, in their radiation, only half a circle, were designated by Gall and Spurzheim the *diverging fibres.* The third set of fibres, which converge towards the centre of the brain, the transverse commissural, were distinguished as the *converging fibres* by the same authors.

The above descriptions demonstrate that the encephalon or brain in the human subject is not a large solid mass of matter, in the interior of which are cavities scooped, as it were, out of its substance, to be appropriately denominated ventricles, but that it really consists of ganglia or collections of cineritious neurine, placed on each side of the mesial line. Some of them being the appropriate ganglia of the nerves of sensation; as, for instance, the olfactory ganglia, the optic ganglia or tubercula quadrigemina, the auditory ganglia or posterior pyramidal bodies, the pneumogastric ganglia or restiform ganglia, the olivary bodies or lingual ganglia; the others being the motory and sensory ganglia, as the corpora striata and thalami nervorum opticorum. The hemispherical ganglia, again, that they might present the greatest possible extent of surface, are folded up into innumerable plaits, and thus cover or surround every other

ganglion within the cranium, so that on first removing the skull-cap, nothing can be seen but the convoluted surface of these extensive ganglia.

And here let me insist upon this important principle in the study of the brain, which is also one of the first ideas that the student should acquire regarding its composition, namely, that it consists of corresponding or symmetrical parts on each side of the mesial plane, and that instead of regarding the fissures of separation between its different portions as forming ventricles or cavities, he must direct his attention to the ganglia which bound the fissure, and the structures called commissures, which, connecting them together, cross the fissure, and necessarily alter its character in different points, masking it, it is true, but not at any place changing the fissure into a true bag or circumscribed cavity. The third, the iter a tertio ad quartum ventriculum, the fourth and fifth ventricles, we have already seen, are in truth no more than the successive dilatations from below upwards of the posterior fissure of the cord; difficult enough to be understood when these are viewed in different situations and unconnected one with the other, as in the ordinary mode of dissecting the brain, but which seem necessary and obvious where its parts are traced in connection with one another.

In conclusion, let me express the hope that these views or analyses, if I may be allowed so to call them, of the component parts of the encephalon, will really simplify the whole of its anatomy, and materially assist the student in acquiring a knowledge of its true character. I wish that custom did not require the student to burden his memory with fanciful and unmeaning names, and that, instead of learning a long catalogue of the contents of the lateral ventricles, as they are erroneously designated, and puzzling himself with the absurd titles of hippocampus major and minor, pes hippocampi, tænia hippocampi, cornu Ammonis, &c., he should be required simply to observe how the spinal columns appear to terminate superiorly in two large tubercles, the *corpora striata* and *thalami*, from the sides and under parts of which the hemispheres spring out, being afterwards reflected so as completely to envelop this bulbous extremity of the spinal cord. In the same way the third ventricle should be described as a fissure separating the two halves of the brain, his particular attention being directed to the commissures which pass across it to connect the different cerebral ganglia with one another. The description of the relative position of these ganglia, the commissures connecting them, and their relation to the ganglia and columns of the spinal cord, comprehend all the information which is either interesting or useful to the student.

PART VII.

CEREBRAL NERVES.

Having thus considered both individually and collectively the various centres of power which constitute the encephalon in man, we shall next direct our attention to the connections of the cerebral nerves, organs which conduct the mandates of the will outwards, and the different perceptions inwards.

Connected with the encephalic ganglia, and that portion of the motory and sensory tract which is contained within the skull, there are, according to some authors, eleven pairs of nerves; in the opinion of others, no more than nine. Each nerve is distinguished by an appropriate name in addition to its title derived from its numerical position. This difference in the number of nerves reckoned by different anatomists, arises from the fact that some describe the 7th pair or facial, and the 8th pair or auditory, as if they were merely portions of the same nerve, whose office was analogous although their distribution might be different; whereas the fact is that they are as distinct instruments of two dissimilar kinds of nervous power as the optic nerve and the olfactory nerve, and are therefore equally well entitled to appropriate and distinguishing appellations. If it is found convenient to employ numerical names in speaking of the cerebral nerves, it is still very important that no single number should be given to two nerves *physiologically* distinct, however closely they may be connected. The glosso-pharyngeal and pneumogastric nerves have, also, like the auditory and facial, been till lately described as forming the 8th pair of cerebral nerves. In this instance we are not perhaps authorized to separate these two nerves from any decided proofs of their having distinct functions; on the contrary, we are rather led to regard the two as mere portions of the conducting instrument of one and the same nervous power. Nevertheless, as one division or root of the old 8th pair is now invariably described under the title of the *pneumogastric*, and the second division is constantly spoken of by the name of the *glosso-pharyngeal* when they have passed out of the cranium, it seems important that the two should still be distinguished by distinct numerical designations when within the skull. Upon these grounds I shall follow the arrangement of Soemmerring, who describes eleven pairs of cerebral nerves: not, indeed, that I am altogether satisfied of the correctness, in a strictly physiological point of view, of this procedure, for if it be proper to separate the seventh and eighth pairs into two nerves each, it would be strictly correct to consider the third pair and the sixth as merely separate roots of the same nerve,

and to describe the two together by the name of *the common oculo-muscular*: for the circumstance of the commissure of the cerebellum separating their roots is merely accidental to their arrangement in a physiological point of view; but the fact of their being described as if they were distinct nerves has frequently led the student to believe that they must be endowed with distinct offices, and wonder why the abductor muscle of the eye should be supplied by a peculiar nerve, while the other muscles, with the exception of the superior oblique, receive their supply from the same source.

Most authors, with the exception of Spurzheim, who fell into the opposite mistake, have erroneously described all the cerebral nerves as originating in the brain. The fallacy of this idea, and the vicious method of description that resulted from it, have been pointed out in the section on Comparative Anatomy, where it has been remarked that the nerves of sensation should be described as terminating in their appropriate ganglia, as has actually been done by Spurzheim, whilst the nerves of motion, on the contrary, should be described as originating there, an extension of the legitimate mode of proceeding which Spurzheim neglected to enforce.

If, after this statement regarding the most correct method, in a physiological point of view, of describing the connection of the cerebral nerves with the encephalon, the student is still desirous of information upon each of these individually, he will find it useful to make out a table for himself, in which he must carefully distinguish between the apparent origin—more properly point of emergence from, or of entrance of the nerve between the fibres of the cerebral mass, and the actual point of union between the neurine of the nerve and that of the cerebral mass itself.

First Pair of Nerves, Olfactory.—The first pair of nerves (the numeration commencing at the anterior part of the brain) encountered are the *olfactory* or nerves of smell; they originate on the lining membrane of the nose, and, entering the skull through the cribriform plate of the ethmoid bone, terminate in the olfactory tubercles or ganglia, which are situated in the cribriform fossæ of the same bone.* In man these ganglia, whose minuteness as compared with those of the horse, sheep, cat, dog, indeed most of the Mammalia, is interesting in a physiological point of view, are entirely concealed by the enormously developed hemispheres.† Each ganglion is connected to the hemispheres by a long narrow *commissure*, frequently designated a *peduncle*, which, lodged in a triangular-shaped groove, passes backwards till opposite the fissura Sylvii, where it splits into three divisions. The most external of these, which is also the longest, and distinctly medullary, runs down the fissura Sylvii to be connected with the anterior extremity of the middle lobe:

* MM. de Blainville and Rolando are almost the only modern authors who seem to be aware of the absurdity of retaining the ordinary mode of describing these portions of the olfactory apparatus as a nerve; in fact, as Rolando remarks, we have in this particular retrograded from the knowledge of the ancients, who never described them by the title of nerves. Willis appears to have been the first to speak of them in connection with the cerebral nerves.

† In describing each pair of nerves, the description will generally be confined to one side only, as being simpler for the student to follow.

this portion of the olfactory peduncle is connected with the anterior commissure, as described by Malacarne in his *Encephalotomie et Microcephalotomie*, by Rolando, and by Gall and Spurzheim. The internal is connected to the posterior internal surface of the under part of the anterior lobe. The middle, which is the shortest, and, strictly speaking, no more than the internal portion of the external, is connected with the posterior edge of the anterior lobe (see fig. 72).

Thus we see the olfactory ganglion in the human brain connected by a commissure with the cineritious neurine of the hemispheres, as in the lowest animals, where we have invariably observed each individual ganglion in succession connected with the others.

The canal which Gall and Spurzheim believed they had discovered in the interior of the olfactory commissure in man was in all probability formed under the blowpipe by the breaking down of the cineritious neurine in its interior, in the same manner as a canal was formed in the spinal cord by the action of the blowpipe in the hands of these anatomists. Tiedemann observed the existence of a canal in the brain of two idiots, an appearance which, I think, must be considered merely as an arrest of development at a period corresponding to the permanent organization of the part in some fishes.

Second Pair.—Optic Nerves.—The *optic* nerves commence in the globe of the eye, from a nervous expansion called the retina. After penetrating the choroid and sclerotic coats of the eye, they enter the skull, through the foramina optica of the sphenoid bone, on the processus olivaris of which they form a commissure, consisting of fibres arranged in the following manner. The optic nerve on reaching this spot divides into two sets of fibres. One passes over to the opposite side, and after decussating with the corresponding fibres of its fellow, reaches its cerebral connections (as described further on), on the different side of the brain to the eye from which it emanates. The other set of fibres do not decussate, but pass to the same side of the brain as the eye from which they are derived. This structure is represented in fig. 107, which is taken from a dissection similar to that figured by Mayo, who was, I believe, the first who demonstrated by dissection this peculiar arrangement.

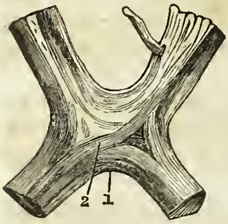
The object of this contrivance is explicable on the following principles.* The rays of light from any object, placed laterally, impinging upon the retina of both eyes, will strike the outer side of one eye and the inner side of the other.

Now, supposing the arrangement just depicted to be correct, (and there is no reason for supposing it to be otherwise,) it follows as a necessary consequence, that the outer and inner side of each opposite retina is formed by one and the same nerve, a peculiarity of structure

* Dr. Wollaston (Phil. Trans. for 1824), in a paper entitled, "On Semidecussation of the Optic Nerve," suggests the probability of such an anatomical arrangement as affording an explanation of the phenomena of single vision. His words are: "Without pretending to detect by manual dexterity as an anatomist, the very delicate conformation of the nerves of vision, I have been led, by the casual observation of a few instances of diseased vision, to draw some inferences respecting the texture of that part which has been called the decussation of the optic nerves, upon which I feel myself warranted to speak with some confidence."

that goes far to account for the circumstance so often reasoned upon, viz., that a single impression is conveyed to the sensorium, though each eye receives the impression. Whether this mode of accounting for it be satisfactory or not, the following facts are extremely interesting, and not sufficiently known, viz., that in those fishes whose eyes are placed so completely on the side of the head that the rays of light from any given object cannot impinge on both retinæ, as, for instance, in the cod and haddock, the optic nerves, instead of forming any union or commissure, cross each other completely, having a membrane interposed between them: in those fishes, again, whose eyes are situated so that even a small portion of their retinæ correspond, as in the carp, we find a few commissural fibres; and in those whose retinæ correspond in every point, as in the skate, we find the commissure as complete as in the human being. While engaged in the investigation of this interesting subject, by the dissection of those animals which I thought would best elucidate it, I was informed by Mr. Wheatstone, Professor of Natural Philosophy at King's College, that Prof. Müller, of Berlin, had given great attention to the same subject, and had carried his observations much further than I have had any opportunity of doing, but uniformly confirming the opinions stated above.

Fig. 106.



This figure represents that curious and beautiful arrangement of the fibres of the commissure in the optic nerve which has been particularly dwelt upon in the body of the work; it is taken, as well as every other drawing of my own, from preparations in my possession; it will not, however, be the less valuable from its corresponding, in the representation of the fibres, to that of Mr. Mayo's in his folio work. 1. Other fibres entering into the composition of the commissure, merely running from one side of the brain to the other, and wholly unconnected with the retina. 2. Fibres from each retina crossing over at the commissure to join those on the opposite side.

The commissure of the optic nerves is not alone formed of fibres derived from the retina of the eye; for, in addition to these, we find a set of fibres highly interesting to the physiologist, and wholly unconnected with the organ of vision. These are strictly commissural, and were first pointed out to me by Mr. Mayo; they run from one side of the brain to the other, forming in their course a curve convex anteriorly and concave posteriorly; they may easily be seen in a human brain that has been hardened in spirits. In the mole, in which the optic nerves are so extremely minute that they have often escaped detection, and by many authors described as entirely wanting, these commissural fibres are found distinctly crossing the base of the brain, opposite the usual situation of the optic commissure; while the small black speck, evidently the rudiment of the eye, is supplied by a minute branch from the fifth pair.

Wenzel, who enters very fully into the question regarding the composition of the optic commissure, sums up in the following words (p. 126): —"Partialis ergo nervorum opticorum decussatio, et evidens autopsia patens non ex solis nervorum opticorum, sed et existorum loci unionis ipsorum, et ex collicorum nervorum opticorum, ex simul sumptorum morbosis affectionibus colligitur: quamquam sileant hac de re Sœmmerring, Ackermann et Michealis. Conclusio ista unica et sola ex tam multis observationibus quas attulimus extra omne dubium esse, nobis videtur."

In the paper already referred to by Dr. Wollaston, I find that he supports his theory by the reference to the complete decussation of the nerves in the sturgeon, cod, &c., where the eyes are on each side of the head.

Fig. 107.

The drawing exhibits the cerebral connection of all the cerebral nerves except the 1st. It is from a sketch of my own taken from two dissections of this part. D. Posterior optic tubercle. The generative bodies of the thalamus are just above it. E. Cerebellum. H. Spinal cord. I. Tuber cinereum. K. Optic thalamus divided perpendicularly. W. Corpus restiforme. X. Pons Varolii. *b b*. Optic nerves: this nerve is traced on the left side back beneath the optic thalamus and round the crus cerebri. It divides into four roots; the first (*g g*) plunges into the substance of the thalamus, the next runs over the external geniculate body and surface of the thalamus, the third goes to the anterior optic tubercle, the fourth runs to D, the testis or posterior optic tubercle. C. Third pair common oculo-muscular, arising by two roots like the spinal roots of the spinal nerves, the upper from the gray neurine of the locus niger, the lower from the continuation of the pyramidal columns in the crus cerebri and pons Varolii, *p t*. *d*. Fourth pair, apparently arising from the inter-cerebral commissure (I *c*), but really plunging down to the olivary tract (*o t*) as it ascends to the optic tubercles. *e m*. Motor or non-ganglionic root of the fifth pair, arising from the posterior edge of the olivary tract. *e*. Sensory root of the fifth pair running down between the olivary tract and restiform body to the sensory tract (for its exact connection, see fig. 108). *f*. Sixth pair, or abducens, arising from the pyramidal tract. *g*. Seventh pair, facial nerve, or portio dura, arising by an anterior portion from the olivary tract and by a posterior portion from the cerebellic fibres of the anterior columns as they ascend on the corpus restiforme, W. *h*. Eighth pair, portio mollis, or auditory nerve, with its two roots embracing the restiform body. *i*. Ninth pair, or glosso-pharyngeal, and *j*. Tenth pair, or par vagum, plunging into the restiform ganglion. J J. Fibres of the optic nerve plunging into the thalamus: immediately below these letters is the corpus geniculatum externum. *k*. Eleventh pair, or lingual nerve; the olivary body has been nearly sliced off and turned out of its natural position: some of the filaments of the lingual nerve are traced into the deeper portion of the ganglion, which is left in its situation; others which are the highest are evidently connected with the pyramidal tract.

M. P. G. Pelletan, "Mémoire sur la specialité des nerves des senses," 1837, after describing this band, says, p. 32, "After their interlacement these optic nerves undergo such an atrophy that they are not more than one-twentieth of a millimetre, the band or chiasma being about six times as large."

The same author recommends the dissection of either fœtal moles or very young ones, in whom the optic foramen is still distinct. "When

the optic nerve has been well prepared, it is to be seen leaving the cranium, and passing between the fasciculi of the ophthalmic nerve of Willis, which it accompanies to the eye."

"The mole," says Müller, (Elements of Physiology, translated by Dr. Baly, p. 767,) "has an uncommonly small optic nerve, and a very delicate chiasma, as Dr. Henle has shown me."

Tracing the fibres of the optic nerve in man from its commissure, we find it a flattened band, which has been designated the tractus opticus. The tractus opticus passes backwards and outwards, running along the external margin of the gray matter (tuber cinereum, figs. 72 and 107, I) which surrounds the infundibulum. The optic nerve either transmits or receives a few fibres from this cineritious neurine, and traveling backwards, becomes still more flattened as it passes beneath (the brain being supposed to be in its natural position in the skull) the crus cerebri (fig. 72, U), just at the point where that body plunges into the hemispheres. The internal margin of the nerve is connected to the crus cerebri by membrane; the external margin is not so well defined in consequence of its giving some fibres to the under part of the middle lobe of the cerebrum. The tractus opticus in this curved portion of its course lies parallel, and almost in contact, with the inferior pillar of the fornix, being *overlapped*, as the student dissects from the base of the brain, by that convolution of the middle lobe of the cerebrum which is called the hippocampus major, which it *runs over* in the natural position of the brain. The tractus opticus in this part of its course has above it the optic thalamus (fig. 107, K). On reaching the posterior part of the crus cerebri, the *internal* margin of this band diminishes, and great care is required in tracing it to its ultimate cerebral connections. The external surface of the optic nerve now becomes much widened; some of its filaments, viz., those forming the internal margin, run inwards and become connected with those little nodules of the optic thalami called the corpora geniculata; other fibres pass still further inwards, ultimately terminating in the tubercula quadrigemina (D).

The more superficial portion of the nerve, when traced backwards, is found winding round the posterior extremity of the thalamus nervi optici, and spreading on the superior surface of that ganglion, becomes intimately connected with it. The internal portion of this layer is attached to the peduncles of the pineal gland. This connection of the optic nerve with the surface of the posterior cerebral ganglion or optic thalamus may be distinctly and easily demonstrated on the brain of the sheep, in which animal the deeper portion is not so large as in man. I have not been able to trace this superficial portion of the nerve into the hemispheres beyond the external border of the thalamus. The remaining portion of the nerve continues its course backwards, and, spreading as it runs, passes also a little outwards. It now splits into two portions, the division of which cannot, however, be seen on the surface; for one portion is placed beneath the other, and plunges into the substance of the thalamus (fig. 107, *g g*), where it terminates. I first described these fibres in a letter published in the Medical Gazette, vol. xxi. They may easily be shown even in a brain which has not been hardened in alcohol,

by making a section longitudinally through the tractus opticus and thalamus nervorum opticorum (fig. 107).

It must be evident from this description, that, notwithstanding the assertion of Spurzheim that "it was a great error to consider the eminences called *optic thalami* as the sources of the optic nerves," these nerves are intimately connected with them. Nevertheless, it is very certain that the optic thalami have a more immediate relation to the hemispheres of the brain than to the organs of vision. They are always in proportion to the size of the hemispheres, and, consequently, are found of greater size in man than in any other animal.

S. W. Stein, in a thesis on the origin of the optic nerve,* considers it as decided "that the optic nerves are connected to the thalamus, and that this organ connects the optic nerves to the whole brain." Rolando denies that the optic nerves arise from, or terminate in, the tubercula quadrigemina, asserting that they take their origin from the thalamus alone.† This statement is altogether untenable with the parts before us.

Third Pair, or common Oculo-muscular Nerve.—The *third* pair of nerves, the *common oculo-muscular*, emerges from the cerebral mass at the inner side of the crus cerebri, the medullary fibres of which, as already explained, are continuous with the motory tract of the spinal cord. This is not, however, the real origin of this nerve; for if it be traced carefully, it will be found not merely to be connected with the surface of the crus cerebri, but dipping beneath it, and there dividing into two portions: one of these ascends through the pons Varolii to be connected with the motor tract in its passage through that commissure; the other passes through the locus niger, and splits in five or six white threads, which, separated by the gray neurine, present a beautiful appearance in a fresh brain (see fig. 107, *c*). Mr. Grainger first demonstrated this arrangement to me. These filaments, after traversing this deposit of cineritious matter, reach those fibres which the motor tract sends through at this point to the inter-cerebral commissure or processus è cerebello (fig. 102). From this origin the third nerve passes forwards on the outer side of the posterior clinoid process, and penetrates the dura mater midway between the anterior and posterior clinoid processes, where it enters a space left between the under surface of the dura mater and the side of the sella turcica, which, we have seen, constitutes the cavernous sinus. It runs along the upper part of this sinus, quitting the cavity of the skull at the foramen lacerum orbitale, and thus entering the orbit, within which it is distributed to the levator palpebræ, and to the levator, abductor, and depressor oculi. The more particular distribution of these nerves will be found described in most of the elementary anatomical works, to one or other of which I shall therefore refer my readers for further information.‡

Fourth Pair, or inner Oculo-muscular.—The *fourth* pair of nerves, also called the *pathetic*, and the smallest of the cerebral nerves, emerges from the surface of the inter-cerebral commissure, close to the optic tubercles.

* De Thalamo et origine nervi optici, &c. Hauniæ, 1833.

† Page 92, op. cit.

* Let me here particularly recommend the excellent practical manual of my friend and colleague Mr. F. Le Gros Clark.

It arises much deeper from the olivary portion of the pyramidal or motor tract (107, D). The fourth pair of nerves, at their origin, are connected together by a distinct commissure, more evident in some brains than in others. From this origin they take their course, between the cerebrum and cerebellum, along the edge of the tentorium, by which membrane they appear to be conducted to the posterior clinoid processes, where, entering the cavernous sinus, they take their course, in the posterior part of that cavity, just below the third; but as they approach the foramen lacerum orbitale, they cross above the third pair, and, on their entrance into the orbit, are situated to the inner side of the third pair: they supply the superior oblique muscle of the eye.

Fifth Pair, or Trigeminal.—The *fifth* or *trigeminal* consists of two portions, the one for sensation and the other for motion. The sensory portion commences by numerous filaments from the surface of the mucous membrane of the nose, of the palate, from the pulpy structure of the teeth in both jaws, from the papillæ of the tongue, from many parts contained within the orbit, the lachrymal apparatus, the conjunctiva, &c., and from the skin covering the face. The numerous filaments from all these sources are collected into separate portions, which pass individually into the skull. The first division passes through the foramen lacerum orbitale; the second through the foramen rotundum; and the third, through the foramen ovale. Under the dura mater in the temporo-sphenoidal fossa, they enter the lower edge of the cineritious matter of the semilunar ganglion of the fifth nerve. From the concave edge of the semilunar ganglion other fibres arise, which, passing over the anterior surface of the petrous portion of the temporal bone, penetrate the dura mater on the outer side, and below the posterior clinoid processes. They then run direct to the upper edge of the pons Varolii, and, passing between the fibres of this commissure, descend completely through its substance, maintaining their individuality down through the medulla oblongata, till they terminate in the posterior portion of the antero-lateral columns of the spinal cord, about an inch and a half below the pons Varolii, as represented in fig. 107, *e*; and fig. 108.

This termination of the sensory root of the fifth is so close to that of the motor division, that Dr. Alcock considers that they arise from the same tract. This is not the case, as the olivary tract to which the motor root is attached, is on the outer side of the sensory tract, and distinct from it (see figs. 94, 107).

The motory portion of the fifth nerve, again, does not arise, as usually described, from the continuation of the anterior columns or motory tract while passing through the pons Varolii or commissure of the cerebellum, but passing beneath the inter-cerebral commissure, very close to the cerebellum, as designated in fig. 107, runs from this point downwards to the olivary portion of the motor tract, as it ascends to the optic tubercles. This root of the fifth pair of nerves is described by Dr. Alcock, in his admirable article "on the Fifth Pair of Nerves," in the Encyclopædia of Anatomy, parts xi. and xii., as arising from the anterior columns of the spinal cord, where they form part of the medulla oblongata. I have not yet succeeded in tracing it so low down as that point. The motor root emerges from the pons Varolii, almost close to the spot

where the sensory division enters it, after which it is applied to the sensory portion of the nerve. As it then passes through the same foramen in the dura mater, and enters the temporo-sphenoidal fossa, it slides behind the semilunar ganglion, to which it is connected by membrane, but not by neurine. It quits the skull at the foramen ovale, and is then distributed to the muscles concerned in the motions of mastication, viz., the masseter, temporal, pterygoid, and buccinator.

To recapitulate: the motory portion of the fifth nerve emerges from between the fibres of the pons Varolii, very close to the spot where the sensory portion enters: but in all cases in which I have dissected it, the motory is separated from the sensory portion by a bundle of fibres of the pons Varolii, of variable thickness. If the nerve be traced with great care—which is necessary, for it is very thin and easily torn—it will be found running backwards and upwards, towards the inter-cerebral commissure or processus è cerebello ad testes, behind the fibres of which it descends, until it reaches the medulla oblongata.

Sixth Pair, or Abducentes.—The *sixth* pair arises from the motor tract, at the inferior edge of the commissure of the cerebellum, just as it is about to pass through that structure, proceeding immediately from the portion of the anterior columns known as the pyramidal bodies; the nerve directs its course forward towards the upper edge of the basilary process of the os occipitis, at which point, or at the distance of about half an inch below the posterior clinoid processes, it penetrates the dura mater. It then advances upwards, and, crossing the superior angle of the petrous portion of the temporal bone, it enters the cavernous sinus, where it crosses the carotid artery at nearly a right angle, being joined at the anterior edge of the vessel by some filaments from the sympathetic nerve or cyclo-gangliated system, which accompany the sixth nerve into the orbit, and are connected with the lenticular ganglion.

The sixth nerve, in its course through the cavernous sinus, is situated the most internally; but under the transverse spinous process of the sphenoid bone, and just previous to its passage through the foramen lacerum orbitale, it is crossed by the ophthalmic division of the fifth pair in its course from the orbit to the semilunar ganglion. The sixth nerve is finally distributed to the abductor muscle of the eye. This nerve, let it be remembered, in a physiological point of view, is merely a portion of the third, its separation from which by the pons Varolii is perfectly analogous to the separation of the roots of the spinal nerves by a blood-vessel running between them, and of no greater physiological importance.

Seventh Pair, Facial, or Portio Dura.—The *facial* nerve, which emerges from the groove between the corpus pyramidale and olivary, just below the pons Varolii, may be traced backwards through the substance of that commissure in which it runs immediately to the inner side of, and in contact with, the sensory root of the fifth pair of nerves (see fig. 108). On arriving even with the posterior and superior surface of this portion of the fifth pair of nerves, the seventh appears to split into two parts, the one running inwards to be connected with the olivary portion of the motor tract of the spinal cord in its passage through the pons Varolii, the other division proceeding outwards to be connected with that por-

tion of the corpus restiforme which I have described as being derived from the motor tract of the cord (see figs. 89 and 90).

From this origin the seventh nerve passes forward to the foramen auditivum internum, passing through which, and entering the stylomastoid canal, it quits the skull at the inferior orifice of this canal, where, becoming external, it is finally distributed to several of the muscles taking their rise from the styloid process of the temporal bone, to the platysma myoides, and to all the muscles of the face.

Eighth Pair, Auditory, or Portio Mollis.—The *eighth* or *auditory* nerve commences from the pulp which lines the labyrinth of the ear. Its fibres gradually unite so as to form a single cord, which quits the temporal bone at the foramen auditivum internum, and directs its course to the posterior part of the medulla oblongata, being connected to the facial nerve by cellular membrane. On reaching the medulla oblongata opposite the inferior edge of the pons Varolii, where the facial nerve emerges, the auditory splits into two portions (fig. 108). One of these passes through the substance of the medulla oblongata anterior to the corpus restiforme, and plunges into its appropriate ganglion,* the posterior pyra-

Fig. 108.

This figure exhibits the origin of the facial, not as it is usually described, but as I found it on three preparations which I dissected in succession. The origin of the auditory, split by the restiform body (w) by two roots, the inner from the olivary tract as it passes through the pons, the other from those fibres of the anterior columns which cover the corpus restiforme (w), as shown in this figure, has been known for some time to a few anatomists, but is not usually described so in most systematic writers.

* Foville gives the following strange doctrine, as it appears to me (p. 507, op cit.):—"The enlargement known under the name of the Gasserian ganglion, and assimilated to the true spinal ganglia of the posterior roots of the nerves, seems to us to differ essentially from them, and that the *ruban gris*, or the gray matter on the posterior fasciculus, and united to the auditory nerve, might quite as legitimately be assimilated to a spinal ganglion. We consider the *ruban gris* as a part of the gray substance of the posterior fasciculus spread upon the surface of the cerebellar ventricle, and concurring to form the roots of the auditory nerve. The true ganglia of the auditory and trigeminal are to us the cerebellar hemispheres and the vermiform eminences."

midal body (fig. 78). The other, which is the posterior division of the nerve, winds round the restiform body, which is thus hid between the two portions of the nerve as in a fossa, and then crossing the posterior fissure of the cord or fourth ventricle, forms by its separation three or four white lines, which are usually very distinct (fig. 78). Meckel* states that he has sometimes found the whole of these lines deficient, sometimes on one side and sometimes on both, and that Prochaska and Wenzel have observed them to differ on the two sides of the brain. Meckel views these striæ as not merely the roots of the auditory nerve, but as connected both with the trigeminal and pneumogastric nerves.

Ninth Pair, or Glosso-pharyngeal Nerve.—The *ninth* pair, called also the *glosso-pharyngeal* nerve, arises from the pneumogastric or restiform ganglion and cerebellic fibres of the anterior columns, immediately above the pneumogastric nerve, by one or two roots (fig. 107, *i*). It runs forwards to the foramen lacerum posterius, passing through which it quits the skull, separated from the jugular vein by a process of dura mater and a spiculum of bone; and passing down the stylo-pharyngeal muscle, is finally distributed to the muscles of the pharynx and tongue.

Tenth Pair, or Pneumogastric.—The *tenth* pair, the *pneumogastric nerve* or *par vagum*, is a compound nerve, like most of the spinal nerves; that is to say, it consists of two tracts of neurine bound up together, the one for sensation, the other for motion. The motor filaments of the nerve are not entirely conductors of volition, for most of the muscular fibres that are brought into action by this nerve are independent of the will; the only exception being the muscles of the larynx concerned in the production of vocal sounds: and as one portion of the tract of volition runs close upon the posterior edge of the corpus olivare, from which these filaments probably arise, we have no difficulty in reconciling the fact of one portion of the nerve being destined for voluntary and the remainder for involuntary motion and sensation, as the constitution of this nerve is proved to be by the most accurate experiments and observations. This nerve has two origins or central attachments, one to the cerebellic fibres of the anterior columns as they form part of the restiform body; the other may be traced through the fibres of the restiform body into some gray matter at the posterior surface of the cord, the restiform ganglion (fig. 107). This deposit of cineritious neurine is both physiologically and anatomically distinct from that in which the auditory nerve terminates, as I have shown by repeated dissections of this part in the human subject, and in the calf, horse, and other animals, as before stated in the section on comparative anatomy (see figs. 52—56). Stilling describes this gray matter as the ganglion of the pneumogastric nerve. Accompanying these nerves in their passage from the skull is a spinal nerve, which, instead of quitting the vertebral canal like the spinal nerves in general, enters the cavity of the skull by the foramen magnum, and adding itself, as it were, to the glosso-pharyngeal and pneumogastric, is from this circumstance called the *spinal accessory*.†

* Anatomie, tome ii. p. 614, n.

† "In the medulla oblongata," says Foville (p. 500), the nerves of the posterior fasciculus are grouped into two distinct cords of great importance—the pneumogastric and glosso-pharyngeal." His description of their origin is most meagre and unsatisfactory. He states

Eleventh Pair, or Lingual Nerve.—The last of the cerebral nerves is the *lingual*, or the *eleventh* pair. This nerve arises in a groove between that portion of the anterior columns of the medulla oblongata usually designated the pyramidal bodies, and the corpora olivaria. I believe that its origin, like all the spinal nerves, is double, one set of fibres being connected with the brain through anterior columns of the cord, and the other with the gray matter; the olivary body being to this nerve what the anterior peaks of gray matter are to the other spinal nerves. Mayo states* that some of the "fasciculi of the lingual nerve penetrate to the gray capsule in the olivary body." It commences by several filaments, which being collected together, the nerve they compose quits the skull at the foramen condyloideum anterius. It is distributed to the muscles of the tongue and also to those of the os hyoides, viz., the omohyoideus and sterno-hyoideus, which fix the bone inferiorly.

Regarding the origin of this nerve, Foville states really nothing. He says† it is detached from the medulla oblongata between the corpus pyramidale and olivary body, but not one word regarding its connection with the interior of the medulla. Stilling‡ traces it to the posterior surface of the cord into what I have described as the auditory ganglion; but I think he is mistaken.

that the arciform fibres of Rolando unite with the pneumogastric and glosso-pharyngeal nerves, and then goes on to say, "There are certainly some difficulties which have not yet been resolved in a satisfactory manner relative to the roots of the pneumogastric and glosso-pharyngeal nerves."

* Plates of the Brain, VII. fig. 2. † P. 527.

‡ P. 21, op. cit.

PART VIII.

VESSELS EMPLOYED IN THE CEREBRAL CIRCULATION.

As the brain receives one-fifth of the whole amount of blood circulating in the body, the student will not be surprised to find it supplied with this fluid by four large arteries, the internal carotids and the vertebrals.

The internal carotid arteries are derived from the common carotids opposite the os hyoides: ascending from their point of origin, they reach the base of the skull, and enter its cavity by the *foramen caroticum* and *carotid canal.* The course of the vessel in this canal is worthy of observation. Changing the nearly vertical course they held at the external orifice for one almost horizontal in its direction, they advance forwards and inwards through the space of about an inch; they then form a curve, resume their nearly vertical course, and quit the carotid canal by the *foramen caroticum internum.* At this point the vessels bend forwards horizontally again, passing through the cavernous sinuses, groove the outer surface of the sella turcica, and at the inner side of the anterior clinoid processes, they pierce the dura mater and enter the proper cerebral cavity. It is impossible to follow the two carotid arteries in this way without the peculiarity of their course forcing itself upon the attention. The changes from a perpendicular to a horizontal direction cannot have been ordained without some peculiar purpose to be fulfilled, and the end most probably has been to protect the delicate structure of the brain from any ill effects which the suddenly increased or hurried action of the heart would have been liable to produce had the tube been perfectly straight and the wave of circulating fluid been suffered to arrive directly, and with its force unbroken, within the cavity of the skull.

This view of the subject is corroborated by the existence of that complicated plexus of vessels, called the *rete mirabile*, emanating from the internal carotid artery, and situated at the base of the brain. This beautiful arrangement of the carotid arteries is to be remembered in connection with the *protective* apparatus of the brain.

The branches of the internal carotid artery, as regards the brain, are three in number; two supplying the brain immediately, and one simply forming a communication or anastomosis with the branches of the vertebral artery. The two first are the *anterior* and *middle cerebral arteries.*

The student will meet with very accurate delineations of these arteries in Professor Richard Quain's folio work on this subject; the most valuable work which for years has issued from the press of this country,

estimated either for the practical importance of its facts, or for its beauty as a work of art.

The anterior first runs inwards towards the great median fissure, where approaching very close to its fellow on the opposite side, the two are united by a short transverse branch, called the *transverse artery* of the cerebrum. The anterior cerebral artery continues its course in the anterior part of the median fissure between the two lateral hemispheres, giving off numerous branches in its course, winding round the great transverse commissure, and running backwards on its upper surface, where it receives the name of *artery* of the *corpus callosum.*

The *middle cerebral* runs deeply within the fissura Sylvii, through which it continues its course, and ultimately reaches the upper surface of the hemispheres.

The third branch of the carotid, called the *communicating artery*, is small but interesting; for running backwards, and joining with the posterior artery of the cerebrum, a branch of the basilary artery to be described further on, it connects these large arterial channels together, and lessens the danger of accident to the brain from obstruction to the circulation in one channel, and from an irregular supply of the vital fluid. When tracing the connection of the two communicating arteries with the basilary branches, a perfect arterial circle will be observed to be formed, the sides being constituted by the communicating artery, the posterior part by the basilary, the front by the anterior arteries of the cerebrum and the transverse artery. This curious circle is celebrated under the title of the *circle of Willis*, who first described it. This free anastomosis is of the greatest importance to such an organ as the brain, for if by any accidental circumstance the flow of blood is arrested in one channel, there is another immediately ready for it.

The *vertebral arteries* arise from the subclavian at the lower part of the neck, immediately anterior to the passage of that artery between the scaleni muscles.

The vertebral has a long course from this point to the cavity of the skull, and nature has beautifully provided for its protection by sending it through a bony and ligamentous canal, bored, as it were, for it in the transverse processes of the cervical vertebræ. This vessel, though much smaller than the internal carotid artery, does not run in a direct course from the heart to the skull, nor begin to distribute its blood to the brain, till it has undergone a succession of curves by which the impetus of the contained blood must be materially diminished. On quitting the foramen in the transverse process of the first cervical vertebra, the artery courses round the articulating process of that bone, and, like the carotid, taking a horizontal direction, it enters the skull through the *foramen magnum.* Within the cranial cavity the two vertebral arteries approach each other, and on the basilary process of the occipital bone, they inosculate at an acute angle and form a single trunk. The single artery thus produced is designated from its relation to the occipital bone, the *basilary* artery.

The branches of the vertebral are three in number; two to the spinal cord and one to the cerebellum. The two arteries to the cord called the *anterior* and *posterior spinal arteries,* though of small size at their origin,

run the whole length of the vertebral canal to the os coccygis, giving off numerous branches in their course. Their calibre, however, is almost undiminished even to their termination, in consequence of their being reinforced by frequent anastomoses with the branches of the deep cervical, intercostal, and lumbar in particular.

The branch to the cerebellum is called the *inferior artery of the cerebellum*, and supplies, as its name indicates, the under surface of that portion of the brain.

The branches of the basilary artery are three in number on each side. One of these is not, however, distributed to the brain, but to the internal ear. Of the other two, one supplies the cerebellum, called, in distinction to the last mentioned cerebellic artery, the *superior artery of the cerebellum;* the other is distributed to the cerebrum supplying the posterior surface of the hemisphere, and is called the *posterior artery of the cerebrum.*

In relation to cerebral circulation we must refer to the thyroid gland; for there is now but little doubt that this sanguineous gland acts as a diverticulum to the brain. I have long thought so, and for years was in the habit of mentioning to my class the facts which supported such an hypothesis. The recent accurate and extended researches of Mr. Simon,* have, I think, fully established this view of its office. The following are Mr. Simon's conclusions.

1. The thyroid gland, or an organ representing its place and office, may be found in all vertebrate animals.

2. It does not appear (as is the case with some organs) to belong to these animals merely in behoof of the great general completeness of their organization, but seems to have a particular reference to that *specific character* which binds them together as a natural section of the animal kingdom—namely, the aggregation and more perfect development of their nervous centres; for

3. The gland, shifting its position most variously, yet always maintains an intimate *relation to the vascular supply of the brain*, always is so nourished that it can alternate a greater or less nutrition, according to the activity or repose of that nervous centre.

4. The organ which in certain fishes represents a rudimental form of the thyroid, is plainly a mere *diverticulum* to the cerebral circulation; in the remaining fishes (where a more perfect thyroid exists), as likewise in the ascending scale of vertebrate animals, there is no essential change from the vascular organization of the branchiola—there is simply the superaddition of a glandular structure. The thyroid is but a higher development of the branchiola. What was a mere capillary plexus now has gland-cells intermingled with its texture.

Probably, then, the use of the secretory actions occurring in the thyroid gland is to be found in harmony with the obvious intention of its vascular supply; as the latter is diverticular, so we may expect the former to be vicarious or alternative.

* Phil. Trans., Part II., 1844.

PART IX.

DEVELOPMENT OF THE BRAIN.

The development of the human brain is a subject which every philosophical inquirer into the laws of organization will find invested with peculiar interest. The vast mass of facts which have been accumulated for its elucidation are amongst the most satisfactory and conclusive in proof of the existence of general laws instituted by an Almighty power, and in conformity with which every organ in the animal series is found to be framed on one beautifully simple and harmonious plan; and as it is only by the discovery of the general laws which regulate the phenomena of vitality that we can ever expect to raise the study of physiology to its legitimate rank among the natural sciences, we ought to recognize with especial gratitude the well-digested store of interesting facts contained in the works of Tiedemann, Serres, the Wenzels, and Doellinger, on the evolution of the brain. Newton, whose vast discoveries in another of the realms of nature have raised him so far above his fellow mortals that we almost reverence his name, showed us that true philosophy simply consists in the discovery of the universality of a fact. How abundant, since Newton's day, has been the harvest to those whose researches have been guided by this simple principle, to which alone we are indebted for any knowledge we possess of the laws by which the Creator governs the universe; for we perceive, as Dr. Paley finely expresses it, that "God has been pleased to prescribe limits to his own power, and to work his ends within those limits. The general laws of matter have, perhaps, the nature of these limits: its inertia, its reaction, the laws which govern the communication of motion, of light, of heat, of magnetism, electricity, and probably of others yet undiscovered. These are general laws, and when a particular purpose is to be effected, it is not by making them wind and bend and yield to the occasion, (for Nature with great steadiness adheres to and supports them,) but it is, as we observe in the structure of the eye, by the interposition of an apparatus corresponding with those laws, and suited to the inquiry which results from them, that the purpose is at length effected."*

This simple view of the existence of fixed laws, established by the Almighty, is not, however, confined to mere matter and its properties: the scientific physiologist has reason to believe that there are similar laws which regulate vital phenomena, and produce results, without the constant and immediate agency of the Supreme Being.

* Natural Theology, chap. iii.

It is told of Newton, that one day when meditating on the simplicity and harmony of the laws which regulate the universe, and struck particularly with the relations and uniformity of the masses of the planetary system, his thoughts reverting thence to the animal kingdom, whose wonderful organization attests in no less degree the supreme wisdom and power of a creating Providence, he exclaimed, "I doubt not that animals are subjected to the same uniformity." The only true philosophical plan upon which any branch of physiology can be studied, is to follow out this idea of Newton, and strive to discover such an harmonious arrangement among its objects; for example, to attain a knowledge of the great principle which is in operation during the life, or which presides over and regulates the development of the individual beings composing the animal kingdom. And here we must carefully guard against being seduced by the vain attempt to gain a knowledge of the ultimate *cause* of vital phenomena; we must strictly content ourselves with observing those phenomena so as to ascertain their relations, their harmony one to another, and their effects. It is, indeed, only by studying physiology on these principles that it can ever truly deserve the name of a science, or afford us that clear and steady light which will guide us philosophically amid the intricate paths of pathology and therapeutics.

Physiologists in general have too much neglected to conduct their studies in accordance with this idea of Newton; they have too constantly amused themselves with creating theories on one or two isolated facts, or in vainly searching after the ultimate cause of vital phenomena: it is but of late that they have begun to content themselves with observing their uniform relations and with scrutinizing their effects, and that they have ceased from being the laughing-stocks of true philosophy.

If, indeed, we required proof of the present imperfect state of physiology, and the mean rank which it holds in comparison with the other branches of natural philosophy, we have only to refer to cotemporary writers, where we still find such passages as the following, in which the writer, after stating how ignorant we are of the nature of the intellectual faculties in man, goes on to say: "Nay, the springs and wheelworks of animal and vegetable vitality are concealed from our view by an impenetrable veil, and the pride of philosophy is humbled by the spectacle of the physiologist bending in fruitless ardor over the dissection of the human brain, and peering in equally unproductive inquiry over the gambols of an animalcule." Surely we ought, after this, to see how absolutely necessary it has become to cast aside crude and ill-digested hypotheses, and to study physiology under the guidance of the general laws of nature deduced from an unprejudiced observation of fact and circumstance. Such a sweeping assertion of the fruitlessness of the labors of the physiologist as we have above, is by no means applicable to the *nature* of his studies, though it is to the *mode* in which they have usually been conducted; for the physiologist is just as competent to inquire into the *causes* of *vital phenomena*, as the natural philosopher is into those of *physical phenomena:* neither the one nor the other can ever ascertain the ultimate cause of anything. All that can be done in either natural philosophy or physiology is to study the mutual relations in which

phenomena stand to one another, and thus to trace their connection and possible dependence.

The mature human frame, which, in its perfect adaptation to fulfil the ends of its existence, strikes the philosophical anatomist with admiration, does not result from the gradual increase of an exact though minute representation of its perfect form; but during the course of its development, and while gradually progressing towards its ultimate perfection, its constitution temporarily assumes many forms which are permanently retained by one or other of the members among the lower orders of creation.

The facts which prove the existence of this law of progressive development are derived from observation of the different organs at different periods of the fœtal existence; and in no set of organs is its truth more clearly shown than in the various component parts of the nervous system, as the reader will discover by giving his attention to the observations on its development which follow. The same thing may also be said in regard to the law which governs the development of the vascular system; and as the circumstances are here peculiarly interesting, and may be made introductory to those of the subject we have especially in hand, I shall make no apology for presenting a few of them in this place.

For instance, the first appearance of the heart in the human embryo is that of a mere pulsating vessel without any division into cavities, or thickening of its walls; an arrangement which in all its simplicity is met with as the sufficient instrument for effecting the circulation in the perfect insect.

The next step consists in the gradual dilatation of this tube into a sac, previously to its division into four cavities: and this corresponds with the single heart of the fish, consisting merely of an auricle for the reception of the blood, and a ventricle for its propulsion.

As the development advances, a second ventricle is added to the first on the right side of it, separated from the left by a septum, which is so imperfect that the aorta communicates with both cavities; and the very same arrangement is found to exist in the adult crocodile.

While the septum is being formed in the interior, a notch appears on the exterior, which, extending from the apex to the base, divides the heart in exactly the same manner as it is met with in the dugong.

In the respiratory system, again, we find some most extraordinary changes; those we have remarked in the vascular we could explain on the supposition that they were the necessary and unavoidable steps towards perfection; but when we find the human embryo assuming forms which are afterwards entirely discarded, we can only account for it on the supposition that one general law governs the developments of the whole animal creation. The lungs in the first instance are placed on each side of the vertebral column, like the air-bladders of fishes, without any appearance of trachea or branchial tubes; an arrangement which, though interesting, as being analogous to the permanent state in fishes, has nothing peculiarly extraordinary in it; but finding, in addition to this, and in perfect correspondence with it, branchial apertures on the sides of the neck, the aorta giving off a regular set of branchial arteries

which take their course to the edges of the openings, some of which are afterwards entirely obliterated, while the others are converted into vessels corresponding with the regular distribution of the adult. As the organism of the human fœtus cannot be supposed to be formed with the idea of providing for aquatic respiration like the embryos of fishes, we can no longer doubt that the whole series of phenomena which are taking place during the development of the fœtus, do not result from any special interference of Divine agency for each individual occasion, but from the action of fixed and general laws.

In the development of the nervous system, to which we must next direct our attention, we shall find even more decided proofs of this general harmony throughout the animal kingdom.

For a clear, simple, and accurate account of the phenomena attending the development of the ovum, the reader should consult Dr. Carpenter's excellent work on physiology.

In order to understand the development of the brain, we must briefly trace the very earliest changes which take place in the germinal vesicle, or ovum. A portion of this vesicle becomes opake; the opacity is called the germinal space—*area germinativa.* The nucleated cells of this spot, at first uniformly arranged, so that the whole is obscure, soon begin to accumulate on the circumference, leaving a clear space in the centre. The transparent spot assumes an oval lunar form, transversely to the ovum. If we examine closely the material of the germinal spot at this time, we find that it consists of two layers. The superior is the *animal* or *serous* layer; from it all the organs of animal life are formed. The inferior is the *vegetative* or *mucous* layer; from it are formed all the organs of vegetative life. The transparent line is confined to the animal layer; the vegetative layer is opake throughout.

We may next observe that this transparent tract assumes a pyriform shape, and the edges becoming elevated, a groove or gutter is formed. The edges of this gutter gradually approximate, at first in the centre, and then gradually above and below, so as to form a canal; but the edges do not join continuously at their two extremities. At the superior, anterior, or cephalic extremity, they are separated, so as to form dilatations placed consecutively to one another, the dimensions of which increase from behind forwards. At the inferior, posterior, or caudal extremity, they are equally separated, but in such a way as to produce a laminated figure, which is gradually effaced. The clear edges of this groove seem dotted with square spots, which are the bodies of the future vertebræ.

At very early periods of fœtal existence there is no appearance of any neurine; the parts corresponding to the head and vertebral column are transparent, and contain a limpid fluid; about the fifth or sixth week the pia mater is distinctly perceptible, forming the walls of the canal in which the fluid is contained, arranged in the head so as to form three vesicles. Tiedemann, to whom we are indebted for almost all we know regarding the development of the human fœtal brain, considered that in the first division into cells they are five in number. But Bischoff* has

* Traité du Développement de l'Homme et des Mammifères par T. L. G. Bischoff, traduit de l'Allemand par A. J. L. Jourdan. 1843, p. 182.

proved that the brain consists first of three cells, which are afterwards divided into five. This tertiary division of the encephalic portion of the cerebro-spinal axis accords with the tertiary division of the skull. The skull, as mentioned elsewhere, consists of vertebræ, just like the cervical, dorsal, and lumbar portions of the vertebral column. The number of cranial or encephalic vertebræ is three in number, and hence the same number of primary cerebral cells. The anterior cell appears first, and is shortly afterwards followed by two others; soon afterwards, a fissure appears on the anterior and posterior cell, which thus divide the three cells into five. The anterior and superior wall of the anterior cell increases on both sides of the mesial line with more rapidity than the posterior; so that when we look at it from above it represents first a double vesicle, with a feeble median depression, dividing it into two lateral halves. The two anterior represent the olfactory ganglia and hemispheres; the two middle, the optic ganglia; and the posterior, the cerebellum: the spinal marrow is represented by a long canal communicating with the cerebral vesicles, which in reality are but swellings of a single sac. The description which I have already given of the pia mater, and the mode in which it first forms a continuous canal, may here be again referred to.

The brain of all Mammalia has this vesicular form in the first instance; the embryos of the rabbit or cat are, perhaps, the best that the student can select for his own observation. Rolando gives a very accurate account of the vesicular form of the fœtal brain in Mammalia and in birds.

Fig. 109.

Fœtus of seven weeks. *a.* Projection of the neck.

The peculiar form and general appearance of the fœtus at the seventh week will be easily comprehended by referring to fig. 109, taken from Tiedemann, who represents it as an oblongated mass slightly curved upon itself, gelatinous, and semitransparent.

In this embryo, which was about seven lines in length, and about seven weeks old, Tiedemann was enabled distinctly to observe the structure and disposition of the brain and spinal cord.

The cavity provided for the cord was situated immediately beneath the integuments, the muscles and vertebral arches not being yet formed. On opening this cavity by means of a fine pair of scissors, he perceived the dura mater nearly dividing the cranium into two equal portions; the pia mater beneath it adhered so intimately to the substance of brain and spinal cord, that it was difficult to detach it without destroying the inclosed pulp, the general form of which may be clearly understood by referring to figs. 110 and 111.

On the posterior part of the cord a longitudinal fissure existed, into which the pia mater entered, which has received the name of the spinal canal; at the upper part, where in the adult it forms the fourth ventricle, a thin narrow plate or flattened fasciculus of neurine arose from either side, and inclining inwards, touched, without uniting with, its fellow; thus forming a sort of arch over the fourth ventricle, and constituting the rudiment of the cerebellum (*c*, figs. 110 and 111), about one line and two-thirds in breadth.

In front of the cerebellum were two membraniform productions, the first appearance of the optic tubercles or corpora quadrigemina, taken together about a line in breadth and one in length (*d*). The rudiments of the thalami (*e*), in the shape of two rounded protuberances, were next in order, the space between them being that which corresponds to the third ventricle. In front of these eminences were two others, in apposition to them, about a line in length, and apparently the rounded extremities of the anterior part of the crura cerebri; these were the corpora striata (fig. 110, *g*).

From the corpora striata arose two thin membraniform productions of neurine curving backwards and inwards; these are the first commencement of the hemispheres of the brain (fig. 112).

At this early period there are no traces of the commissure of the cerebellum or of the cerebrum, or of the thalami, or of the longitudinal commissure, called the fornix.

Fig. 110.

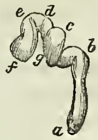


Fig. 111.

Fig. 110.—Brain and spinal row of the same fœtus as represented in fig. 109, seen laterally. *a.* Spinal cord. *b.* Enlargement of ditto. *c.* Cerebellum. *d.* Optic tubercles, or quadrigeminal bodies. *e.* Optic thalami. *f.* Membraniform hemispheres of the brain. *g.* Protuberance analogous to the corpora striatum.

Fig. 111.—Posterior view of the same brain, split and open in all its length. *a a.* Spinal marrow. *b.* Orifice of the canal of the spinal marrow. *c.* Swelling of the spinal marrow. *d d.* The cerebellum split in the median line, and laid like a bridge over the fourth ventricle. *e e.* The quadrigeminal bodies separated from one another in the median line.

The substance of the brain and cord examined with a glass, presented no fibrous appearance; it seemed to be composed of extremely minute globules. It does not assume a fibrous appearance until the commencement of the fourth month. Tiedemann states that he could not perceive any appearance of the cerebral nerves, which he accounts for on the supposition that they were so delicate as to escape detection; but such a supposition appears to me unnecessary, when we recall to mind the facts which I mentioned in the early part of this work, regarding the development of the nerves in the first instance in all the different tissues, and their subsequent union with the brain and spinal cord.

In the following details I have adhered generally to the plan of describing the gradual development of individual parts connectedly, as bringing the whole more simply before the eye of the student than of particularly detailing each change as it takes place from one month to another, which has been faithfully done by Tiedemann and Serres, to whom I must refer the reader for greater minuteness.

It may be laid down as a rule that the spinal cord is formed previously to the brain, not merely in man, but in all the orders of vertebrated animals. At first it consists of two cords, not united posteriorly, by which a deep furrow is formed, which is soon converted into a canal by the union of the opposite halves.

This canal of the spinal cord, which is so distinct in the human fœtus until the fifth month, and in that of the horse and the calf until the sixth, exists permanently of a certain width in fishes, reptiles, and birds. In the fœtal state of the human embryo it is obliterated by the deposition of successive layers of gray matter secreted by the pia mater. But what is, perhaps, more extraordinary is, that the cord in the human fœtus extends to the extremity of the coccyx until the third month, when it ap-

pears, according to the statement of M. Serres, to rise suddenly to the point where it is met with after birth, namely, opposite the second lumbar vertebra. The os coccygis, which, previous to this period, consisted of seven pieces, suddenly becomes reduced to its permanent number, four.

The spinal marrow is of equal calibre, in its whole extent in the young embryos of all classes; it is without enlargement either anteriorly or posteriorly, as in those reptiles which do not possess extremities, as snakes, &c. This appearance corresponds with the absence of extremities at this period of existence; for as soon as they are developed, the cord enlarges at those points with which their large nerves are connected.

The corpora olivaria are not formed until the end of the sixth, or beginning of the seventh month. The interlacement of the pyramidal fasciculi is visible in the human embryo from the eighth week. In reptiles and fishes there is no interlacement at all.

In the second month of fœtal existence the fasciculi of the spinal cord, which are prolonged into the brain, are curved downwards beneath the optic tubercles: this curve remains distinct until the third month. The bundles may be distinctly traced into the optic thalami, and having become more voluminous they then pass into the corpora striata, from the anterior surface of which they may be seen emerging, and spreading like a fan to form the hemispheres. From the internal and inferior side of the thalami, or from the continuation of each crus, a fasciculus of fibres is detached, which descends into the mamillary eminences. These reflected on themselves, and thus directing their course backwards, form the anterior pillars of the fornix, or, more properly speaking, the inferior longitudinal commissure.

All the other fibres of the crura, which are very numerous, are directed forwards and outwards, passing under the corpora striata, forming the hemispheres; and at the posterior part they join, or more strictly speaking form, the posterior pillar of the fornix. In doing so they form a fold, which, projecting on the internal surface of the ventricle, gives rise to that appearance which is called the cornu Ammonis.

The corpus callosum or commissura magna does not exist in the brain of the fœtus in the second month, nor even in the early part of the third. Towards the end of the third, however, it makes its appearance; at first it is very narrow and nearly perpendicular. In its growth it passes from before backwards. By the seventh month its fibres may be traced in connection with those of the spinal cord through the medium of the crura cerebri.

From the description already given of the brains of fishes, reptiles, and birds, the reader is aware that this commissure does not exist in them.

The pituitary gland is not in existence in the second month, nor even at the commencement of the third; but it appears towards the end of it, forming a rather large soft mass.

The very gradual manner in which the cerebellum attains its ultimate complexity, is in perfect harmony with the gradation which it pursues in the animal kingdom.

About the third month the cerebellic fasciculi, which we formerly ob-

served just touching each other, are now united so as to form a concave mass internally, smooth and convex externally, but without any appearance of grooves or leaflets, thus accurately corresponding with the cerebellum in osseous fishes, such as the carp, cod, &c.

In the fourth month the commissure of the cerebellum is perceptible, and is about a line in width. About the fifth month the cerebellum, itself about seven lines in breadth, begins to assume the same appearance as that of the skate; for grooves appear upon the surface, which gradually increase in depth and number, till at the sixth month the stems and branches of the arbor vitæ become apparent, and the part then puts on the exact appearance of that of birds.

In conclusion, let it be remembered that the cerebellum proceeds, in the first instance, from the spinal marrow—in fact, from the two fasciculi which are earliest apparent, and which constitute the corpora restiformia.

The masses of neurine which correspond with the tubercula quadrigemina or optic tubercles in the adult, are in the embryo of the second month merely two plates bending upwards and inwards, but not yet covered by the hemispheres, and in apposition only in the mesial line, their union not being complete until the end of the third month, when, becoming convex externally, they gradually increase in size and become united.

At this period they correspond in appearance with the optic tubercles in fishes and in birds; and it is not until the seventh month that we can perceive any division into nates and testes, or into four bodies instead of two; and even at this period they are scarcely covered by the hemispheres, so that they now resemble those of the Rodentia.

The anterior ganglions of the cord or corpora striata, at the end of the second month, not being yet covered by the hemispheres, are clearly to be seen (fig. 112). Towards the end of the third month, however, when they measure two lines and a half in length (figs. 113, 114, 115, 116), the membranous hemispheres are partially extended over them. These protuberances, which are solid throughout, are united by a transverse band representing the posterior commissure, and their increase from this period is in exact correspondence with the progressive development of the hemispheres. The commissura mollis was not observed by Tiedemann until the ninth month. The Wenzels are said to have met with this commissure in the fifth, and again in the seventh month.

The pineal gland is not to be seen previous to the fourth month, when it appears in the form of a small flattened round body, the peduncles of which, extremely thin, are seen arising from the inner edge of the superior surface of the optic thalami.

This body is not met with in fishes, though it is in many reptiles, as the hawk-bill tortoise, wall lizard, and ringed snake, as also in birds, and invariably in the brains of the Mammalia, varying in size, figure, and structure.

In volume it is much larger in proportion to the size of the brain in the ruminating animals than in man.

The *thalami nervorum opticorum* or *posterior ganglions of the cord*, are just perceptible at the second month. In the commencement of the

third they become more voluminous, and are partly covered by the hemispheres, which structures, being in the first instance mere layers of neurine shooting out from the hinder part of the corpora striata and thalami, give to the corpora striata an appearance of greater size and prominence than they seem to possess afterwards, when the hemispheres have become nearly as thick as themselves. At the period of birth they appear sunk amid the substance of the hemispheres, which then bound the anterior part of the space left between them and the corpora striata and thalami, and which has been so incorrectly designated a ventricle or bag.

Fig. 112.

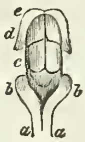


Fig. 113.

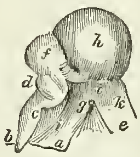


Fig. 114.

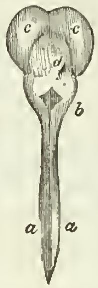


Fig. 115.

Fig. 116.

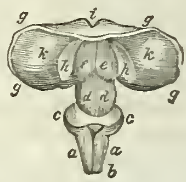


Fig. 112.—Brain of an embryo of nine weeks. *a a.* The two principal columns of the spinal marrow, separated from one another by a longitudinal fissure. *b b.* Cerebellum. *c.* Parts which give rise to the quadrigeminal bodies. *d.* Thalami optici. *e.* Membranous hemispheres, turned backwards and inwards.

Fig. 113.—Brain of an embryo of twelve weeks, seen in the cranium. *a a.* Fragments removed from the cranium, which has been opened. *b.* Spinal marrow. *c.* Swelling of the spinal marrow, which is bent inwards. *d.* Cerebellum. *f.* Elevation which gives rise to the quadrigeminal bodies. *g.* Crus cerebri, or a cord of the spinal marrow which comes down again, and is directed forwards *h.* Membranous hemisphere of the cerebrum, broken down behind and before; it does not yet cover the eminences destined to form the quadrigeminal bodies.

Fig. 114.—Brain and spinal marrow of the same fœtus seen posteriorly. *a a.* Spinal marrow, with its posterior longitudinal fissure. *b.* Cerebellum, and beneath it the fourth ventricle. *c c.* Hemispheres of the cerebrum. *d.* Eminences which are to become the quadrigeminal tubercle, with the fissure which they present.

Fig. 115.—Inferior surface of the brain of the same fœtus. *a a.* Spinal marrow, with the anterior longitudinal fissure. *b b.* Swelling of the spinal marrow, bent forward. *c c.* Peduncles of the cerebellum, which arise from the cerebellum. *d d.* Cerebellum *e e.* Peduncles of the cerebrum. *f.* Mamillary eminences. *g.* Pituitary gland. *h h.* Anterior lobes of the cerebrum. *i i.* The posterior and round appendices which represent the middle and posterior lobes.

Fig. 116.—View of the superior surface of the brain of the same fœtus: the membranous hemispheres are separated from one another and laid aside. *a a.* The two principal cords of the spinal marrow. *b.* Posterior longitudinal fissure. *c c.* Cerebellum *d d.* Masses which are to form the quadrigeminal bodies. *ee.* Thalami optici. *f f, g g g g.* Membranous hemispheres separated from one another and laid on the sides. *h h.* The two corpora striata, which are a little wider anteriorly, and divided into two parts by a slight fissure. *i.* Commissure of the two hemispheres and commencement of the corpus callosum. *k k.* Lateral ventricles, with the radiated folds of the under-surface of the hemispheres.

The anterior commissure does not exist in the second month; but in the third it appears like a thin delicate thread, and its development proceeds in accordance with that of the corpora striata and thalami.

Although in the preceding descriptions of the corpora striata and thalami we have had frequent occasion to speak generally of those layers of neurine which ultimately form the hemispheres, it may be desirable to give a more detailed account of them. This is particularly important as calculated to do away with the false notions that have been entertained on the subject of the ventricles, as well as to convey clearer impressions on the difference between the figurate and convoluted surfaces of the brain. These ends, indeed, can in no better way be accomplished than by following out the development of the hemispheres

of the brain. At any rate I think that if the reader will attentively compare the description which I have given on the subject of the adult brain, of the relations of the hemispheres to the ganglia of the cord, or corpora striata and thalami, no doubt will remain in his mind as to the correctness of the statement made at the commencement of this work, namely, that the ventricles are no more entitled to the name of bags than the space left between any two convolutions of the surface of the hemispheres.

In the fœtus of the second month we perceive springing out from the under part of the corpora striata on each side, a thin delicate membrane, consisting of medullary neurine, which is reflected backwards and inwards, scarcely covering them, invested with pia mater: this is the rudiment of the hemispheres (fig. 112). In the commencement of the third month these membraniform hemispheres completely cover the corpora striata, and towards the end of the month, they have extended over the thalami, not having yet reached the optic tubercles (figs 113, 114, 115 and 116).

Fig. 117.

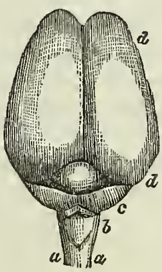


Fig. 118.

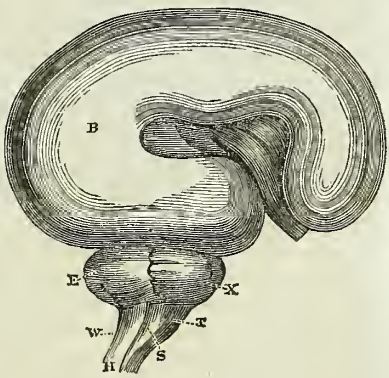


Fig. 117.—Superior surface of the brain of a fœtus of fourteen or fifteen weeks. *a a.* Spinal marrow. *b.* Peduncles of the cerebellum separated from one another, from above downwards, which brings the fourth ventricle into view. *c.* The cerebellum, which has not yet any fissures. *d d.* The right hemisphere of the cerebrum, which does not yet cover the quadrigeminal mass.

Fig 118.—Side view of the brain of a fœtus of twenty-seven weeks. B. Cerebrum. E. Cerebellum. H. Spinal marrow. S. Corpus olivare. T. Corpus pyramidale. W Corpus restiforme. X. Annular protuberance. The fissura Sylvii are very deep, and extend to a great distance on the sides; they lodge the middle cerebral arteries, which distribute almost all their branches to the deep-seated parts of the encephalon, namely, to the corpora striata. The olfactory nerve descends from the fissura Sylvii.

During the fourth month (fig. 117) they have advanced as far as the anterior edge of the optic tubercles, but they do not cover them entirely until the sixth, when they have extended as far as the cerebellum (fig. 118). At this period we may perceive on the surface corresponding to the falx major, some grooves or furrows which are the first steps towards the formation of the convolutions. The upper and lateral surfaces still remain perfectly smooth. At the seventh month the convolutions are very imperfectly developed, though the hemispheres now cover the cerebellum entirely, and upon this division of the cerebral mass, depressions appear here and there, the rudiments of the convolutions and fossa, into which the pia mater dips. The fissuræ Sylvii are distinct, lodging

the middle arteries of the brain, which send numerous branches into the interior.

In the eighth month the hemispheres which cover the cerebellum, and are prolonged even beyond its posterior border, are two inches eleven lines in length, two inches one line in breadth, and one inch ten lines deep. On examining their inferior surface, the anterior, middle, and posterior lobes may be distinctly seen, the boundaries of each being well marked.

At nine months the hemispheres are three inches and four lines in length, and two lines in breadth; they have now exactly the same form as in the adult, and are covered with convolutions and anfractuosities.

After these details, it must be evident that the hemispheres are formed from before backwards, and from without inwards; that at first they consist only of a thin membranous layer of neurine, reflected upon itself from behind forwards, and from without inwards; that they increase in thickness and volume very gradually; and that as they are developed they extend themselves, first over the corpora striata, and afterwards over the thalami, optic tubercles, and cerebellum, so that in the end they entirely cover all these parts.

We observe precisely the same plan adopted in the formation of the hemispheres of the brain throughout the Vertebrata, except that they are arrested at different stages of the development in different species, which the human embryo merely assumes for a short period, and passes on to a more elevated type.

Professor Retzius, of Stockholm, has given the following account of the development of the hemispheres, which is more minute than that of Tiedemann. I am unable to say whether it is more accurate:*—

"In the first period, which corresponds with the second and third months, only the anterior lobes form; in the second period, which is comprised in the end of the third month, in the fourth, and in a small portion of the fifth, the two middle lobes appear: and after this time the posterior lobes. During the first period the descending horns of the lateral ventricles, and the pedes hippocampi, are wanting; these are added in the second period. During a great portion of the first period, the hemispheres do not cover the thalami nervorum opticorum; in the second period they completely overlap these parts, approach the large corpora quadrigemina, cover their anterior part, and then descend by the side of the cerebral nucleus, (cone or stem,) and, as it were, fold round it. If we examine a brain at this period of development, we might, from its external appearance, imagine that the posterior margin of the hemispheres corresponds to their persistent posterior ends and margins, i. e., to those which are their posterior margins in their perfectly developed state. But it is not so. If we open the brain we come at once to the descending horns of the lateral ventricles, in which are the rudiments of the great pedes hippocampi. At a later period, in the fourth month, a small superficial notch is formed at the posterior margins of the hemispheres; and that part of this margin which is above the notch is the first rudiment of the posterior lobes of the hemispheres.

* British and Foreign Quarterly Medical Review, vol. xxii. p. 503.

These, which are thus for a long time only rudimental, begin above the middle lobes, gradually take in their posterior margin, follow it down, as development advances, by the sides of the cerebral nucleus, and terminate at that part of the middle lobes which meet the pedes hippocampi. Even in the brain of the mature fœtus, as well as in the fully developed brains of older persons, the posterior lobes are very clearly separated from the middle lobes by a branching furrow, which is especially distinct on the vertical side of the hemisphere which lies next to the falx."

Having entered generally into the composition of the cerebral mass in fishes, reptiles, birds, and the mammalia, I consider it unnecessary to dwell more fully upon the subject at present than to point out a few of the analogies between them and the human fœtus.

The skate presents one of the most decided specimens of a structure analogous to the fœtal or rudimentary hemisphere of the higher classes, in the two tubercular enlargements which are placed immediately in front of the optic tubercles, and with which the peduncles of the olfactory nerves are connected as in the human subject.

These bodies are hollow, and the walls of the cavity are formed by a membranous layer of neurine reflected backwards and inwards, into which the fibres of the crura cerebri expand as in the human embryo.

In the carp we have also observed rudimentary hemispheres.

The rudimentary hemispheres of the reptiles are equally interesting when viewed in relation to this subject. In the crocodile, each hemisphere represents a membranous sac containing within it the optic thalami, the pineal gland, and the corpora striata, from which ganglia the hemispheres appear to arise, thus corresponding accurately with the same part in its state of evolution at the third month of fœtal existence in the human being, presenting the reflection of neurine which constitutes the hemispheres, extending to the same point behind, and covering the corpora striata and thalami, but leaving the optic tubercles exposed. And so we might in the same manner go on multiplying examples of the truth of the law of progressive development of the hemispherical ganglia: more than has been said seems unnecessary.

The corpora mammillaria do not appear until the end of the third month, and then not divided as they are after birth, but simple and homogeneous.

The above facts which I have laid before my readers on the authority of Tiedemann, Serres, Bischoff, and others, will, I think, thoroughly convince them of the truth of the law which I stated at the commencement of this section regarding the gradual development of the brain and spinal cord on one simple and uniform type: and that the complicated structure which we meet with in the human adult, is at an early period of fœtal existence, as simple in its general arrangement as many of the permanent forms of the lower vertebrated animals, and that in its development Nature appears to have pursued the same plan which she has adopted in the organization of each individual in her vast family, gradually adding one part after another, and at the same time concentrating the whole, each fresh addition changing the appearance of the several parts, so that unless the chain be observed from its very commencement, all

the analogies which are so palpable when we proceed step by step are obscured, and even made altogether incapable of demonstration.

Let me not, however, be misunderstood, when speaking of the addition of fresh parts, for the brain of man even in its state of perfect development consists of the same number of *ganglia* as that of the Vertebrata in general, though the amazing size of the hemispherical ganglia and the cerebellum, with the addition of fresh commissures, give to the human brain an appearance wholly unlike that of the reptile and the fish.

PART X.

PHYSIOLOGY OF THE CEREBRO-SPINAL AXIS.

This is a subject which every candid physiologist approaches with great diffidence, for though much has been done in the last ten years, still much remains in doubtful obscurity.

In the anatomical sections of this work I have purposely introduced much physiology, in order to give more interest to the anatomy than is usually attached to mere details of structure, without reference to function, so that in this section it will only be necessary to give a summary of what has been more or less touched upon previously.

The sources of our information on the functions of the nervous system are fourfold.

First. Observation of the parts composing it in the lower animals, and the relation which they bear to those of man, considered in connection with the development of their organs of sense and muscular actions. This source we have already availed ourselves of in the section on comparative anatomy, and observed how clearly the development of the nervous centre keeps pace with the increase of the animal powers; and I need only advert to the important discoveries of Mr. Newport, among others, to remind my readers that this is one of our most unerring sources of information.

Secondly. Experiments on living animals.

Thirdly. Pathological facts.

Fourthly. Observations between the relations of the size of the human cranium in individuals, and their manifestations of intellect. Also observations on the relation between the external configuration of the cranium in individuals, and their manifestations of particular degrees of intellectual power, propensities, and sentiments.

Though the deductions which are made from experiments on living animals are so liable to error that reliance must not be placed upon them as unerring sources of knowledge, they have afforded very important and valuable information on this subject. I do not agree with the objections which Mr. Combe has urged against the experiments on the brain as useless in the elucidation of its functions, for it appears true that, notwithstanding the various sources of error to which experiments on living animals are exposed, some very important facts have been elicited, which, taken in conjunction with those derived from comparative anatomy, pathology, and observation during life, have afforded collateral evidence of the separate offices of different portions of the brain and nervous system. As regards our knowledge of the functions of the

nerves and the spinal cord, experiments have been invaluable; and in reference to the encéphalon, when taken in connection with the facts of comparative anatomy, they have shed much light on the subject, particularly those of MM. Flourens and Bouillaud. In so far as this mode of investigation is admissible, the results obtained by these authors are perhaps the best authenticated and the most satisfactory of any.

If we were not bound to receive with the greatest caution the conclusions of every experimental physiologist, knowing how liable even the strictly honest, (among whom both the above-mentioned authors may be classed,) are to see results as they expect them to be, and not as they really occur, we might be induced to believe, after reading their works, that a great deal more of the functions of the nervous system must be known than is actually the case.

We must guard against extending the mischief which has been done by several recent authors, who have referred to the whole of the results and inferences as if they were so many firmly-established facts in the science of physiology.

From pathology we might naturally expect surer evidence; but even here the physiologist who carefully examines its records is doomed to disappointment.

It is clear that if, in uniform accordance with the derangement or obliteration of individual functions during life, morbid alterations of individual portions of the nervous system were met with after death, no surer evidence could be procured of the connection between function and organic structure. But no certain light has yet shone on physiology from this source.

The last, or fourth source mentioned as affording us knowledge of the functions of the brain, can only yield us instruction as to the office of its surface. But, as we shall see hereafter, the mass of evidence in favor of the belief that the great hemispherical ganglion or cortical substance of the brain is the immediate agent in all mental operations, is, in my own opinion, so conclusive, that it becomes next a most interesting question whether different portions of this ganglion play different parts in the production of mental phenomena. Now I candidly avow that the more I have examined the facts adduced by the supporters of this theory, the more I am inclined to believe that its *general principles* are correct and philosophical. I entirely agree with that talented observer, Mr. G. Combe, that "Phrenology, in its evidence, rests on the same foundation as the practice of medicine. The existence of disease cannot in general be determined by weight or measure, and the characters of diseases can be judged of only by their appearances, or the symptoms which they present. The organs affected—the degree to which they are affected—and the extent to which medicines act on them—are all estimated by the exercise of observation and reflection on mere symptoms. In the practice of medicine, anatomy, physiology and pathology shed their light to help the judgment in its estimates, but they do not reveal the theory of medicine *à priori*, nor do they render it a demonstrative science."

"The same general laws of evidence must necessarily apply to the

study of phrenology. The mental manifestations are not ponderable nor measurable any more than the capacity for pain or pleasure, or the powers of hearing or sight, are so. We estimate the degree in which these susceptibilities and capacities are possessed by different individuals, and regard our knowledge as substantial, and we must of necessity learn to estimate the force of the mental manifestations by a similar exercise of observation and reflection, or remain forever ignorant of mental science." (See Phren. Journ., vol. x. p. 556. On the nature of the evidence by which the functions of different parts of the brain may be established, by Geo. Combe.)

In the course of our observations of the composition and properties of neurine, and on the essential elements of a nervous system, the following fundamental principles have been established, and need only be adverted to in the present section.

1. That vesicular neurine is the source of power.
2. That medullary neurine is the conductor of it.
3. That medullary neurine is also the conductor of those impressions which call forth the power of the vesicular neurine.
4. That the vesicular neurine is collected in masses of variable form and size—the *ganglia*.
5. That the medullary neurine is moulded into cords and bands—the *nerves* and *commissures*.

In an inquiry like the present, the surest path to sound opinions must be first to investigate the office and mode of action of such organs as the *nerves*, which are sufficiently isolated to enable us to experiment on them without being in danger of injuring adjoining organs of the same kind, and performing separate offices, and thus interfering with the result of the experiments; and afterwards to prove the physiology of the central portions, where the problem is more difficult to solve.

Indeed, the facility of exposing the nerves, and the striking results which follow their injury, show the important part which they play as conductors of stimuli. And even Herophilus, Erasistratus, and Galen, perceived that there was a flow of power from the centres of the nervous system and the muscles, which produced their contractions, and from the organs in general to the centres of power which produced the sensations. Further researches have only confirmed the fact that they are mere conductors, not originating the power of contraction in muscles, or perceiving sensations in themselves, but in the first place conducting a stimulus which calls the resident power of muscles, that of shortening themselves, into action, and in the second conducting a something to a certain point, where it is converted into a sensation and perceived; the course of these influences, namely, the one, that of the stimulus to muscular contractions, proceeding from the centre to the circumference, the other, the producer of sensations, from the circumference to the centre.

And though the fact that we can produce contraction in a muscle by pinching a nerve cut off from its connection with the brain, but still in connection with the muscle, might seem to prove that the stimulus to contraction actually resides in the nerve, and is merely called forth by the brain, yet the experiments of Müller (see Müller, *op. cit.*, p. 7917) show that the divided nerves lose this power after they have remained

unconnected for a short time, so that the previous power of exciting contractions must have been derived from the nervous centres, and not generated by the nerves themselves. The experiments of Sir C. Bell, Magendie, and Mayo, have proved that there are nerves subservient to sensation—sensiferous or sensory nerves, and nerves of voluntary motion. The physiological researches of Whytte, Prochaska, and, more perfectly, Marshall Hall, confirmed by the anatomical observations of Grainger, Carpenter, and Newport, have established another system of nerves for the involuntary—the conservative movements of the body, under the title of the excito-motory system of nerves. All sound research and careful experiment prove that a nerve in the whole extent of its course, whether that course is between the fibres of a muscle, in the canal of a bone, in the substance of the spinal cord, in the crura of the brain, or in the masses of the hemispheres, always performs one and the same office, conducting always in one and the same direction.

The spinal nerves are connected with the spinal cord by anterior and posterior roots. Each root consists of two sets of nerves, making, therefore, four sets of spinal nerves functionally distinct. The two anterior are the conductors of volition from the brain to the voluntary muscles, and the conductors of a stimulus to muscular action independent of volition from the ganglia of the spinal cord—the efferent nerves of spinal power. The posterior roots are also binary in their functional power—nerves of sensation, conducting impressions to the brain, and recognized by the conscious being: and conductors of impressions to the spinal ganglia from parts requiring the protective action of muscles too important to be left to the control of mind—the incident nerves of spinal impressibility.

The *spinal cord* is a series of ganglionic centres, structurally homologous and functionally analogous to the jointed ganglionic cord of the articulata, and although we are unable to point out any corresponding anatomical lines of demarkation between them, they are as functionally distinct as the auditory, optic, and olfactory ganglia of the brain. For instance, those cervical centres which give origin, with such undeviating regularity in the Mammal, to the phrenic nerve, endowing that nerve as a conductor with power that keeps the diaphragm in unremitting and unwearied action during the whole of life, must possess the power of acting independently of those lumbar centres from which the nerves of the generative system arise, and by which various muscles are brought into numerous and convulsive actions during the act of copulation. In the latter instance unrestrained action, so injurious to our moral natures, in its excess brings its own punishment—disease and softening of the cord; in the former, constant action is essential to life, and the power is only exhausted by death itself.

Wherever there are distinct centres of power, there are also connecting commissures. The transverse commissures of the spinal cord, connecting corresponding ganglia on opposite sides of the mesial line, are easily demonstrated. Longitudinal commissures connecting them together from below upwards must also exist, though it is not so easy to distinguish them from the longitudinal fibres of the volitional and sensiferous

nerves. It is quite possible that the posterior columns are the longitudinal commissures which connect these ganglia together, and with the cerebrum and cerebellum, as the fibres of these columns terminate in both the grand divisions of the encephalon, though principally in the cerebellum.

The spinal cord consists, then, of ganglia, nerves, transverse and longitudinal commissures, perfectly similar to the longitudinal commissures which connect the jointed cord of the articulata.

The *medulla oblongata* consists of three ganglia on each side of the mesial line—six, therefore, in all. The olivary bodies, most probably the lingual ganglia, the restiform or pneumogastric ganglia, the posterior pyramidal bodies or auditory ganglia. The olivary ganglia are connected with the rest of the cerebral ganglia by means of the olivary commissures, and the important office of those ganglia, if my hypothesis is correct, that they preside over the consensual movements of the tongue, as an organ of speech, explains the reason of such a perfect communication with the rest of the encephalon. Between the pneumogastric ganglia and the brain the commissural communication is not so distinct, and there does not appear to be the same physiological reason to expect it.

The auditory ganglia are imbedded in the sensory tract; but undoubtedly some of these fibres which we have heretofore considered as belonging solely to this system of nerves, must be regarded as belonging to that system of longitudinal commissures which we have seen so distinctly carried out in the brain.

The next anatomical division we come to is the pons Varolii. This, though evidently a great transverse commissure, must also be an instrument of power through the medium of its vesicular neurine; and though we are unprepared to define the nature of its power, it must hold some relation to transmission of motor and sensory impressions by the tracts which in the spinal cord conduct them.

Cerebellum.—The extensive surface of vesicular neurine which constitutes the ganglionic portion of this encephalic centre, shows that it must perform some very important office in the animal economy; that it must, in fact, be a ganglion, or series of ganglia, of great power. Its extensive nervous and commissural connections also support this opinion. The motor and sensory tracts, as they form the restiform bodies and plunge through the substance of its great transverse commissure, have a connection with its nucleated dynamic vesicle. By the intercerebral commissure the cerebellum is intimately associated with the optic, the anterior and posterior cerebral, and the hemispherical ganglia.

From what has been already said in the sections on comparative and human anatomy regarding the function of this organ, the reader will be prepared for my opinion on this subject.

There can, I think, be little doubt but it is a regulator and co-ordinator of muscular action on the one part, most probably by means of the central portion of the cerebellum, viz., the superior and inferior vermiform processes. On the second part, it certainly would appear to hold some relation to the generative function. The pathological and other facts adduced by Drs. Gall, Vimont, and Broussais, on this subject,

are very striking, and almost as conclusive as all other physiological evidence.*

The *locus niger* in the crus cerebri is the next ganglion for our consideration; it is the serial homologue and analogue of the anterior peaks of gray matter of the spinal cord. It is, I suppose, the seat of the excito-motor power of the third pair of nerves, the importance of which in relation to the instinctive and conservative movements of the eyeball need not be insisted on here.

The *tubercula quadrigemina* or optic tubercles, we may fairly conclude, are the instruments by which the physical impressions of light received by the retina are converted into sensations of light, color, form, &c.

The optic thalami and corpora striata, or anterior and posterior cerebral ganglia, are the next in rotation. With regard to the office of these nervous centres, we have already had occasion to consider the thalamus as the essential ganglion of the sensory tract, as the corpus striatum is of that of the motor tract. And I am quite disposed to adopt the ingenious and philosophical theory of my friend, Dr. Carpenter, as enunciated in his review of Mr. Noble's work in the October number of the British and Foreign Quarterly Medical Review for 1846.

The anterior and posterior cerebral ganglia are regarded by Dr. C. as forming part of the series of sensorial centres, of which we have seen other members in the olfactory, optic, and auditory ganglia. That they are independent centres of action, not mere appendages to the hemispheric ganglia, appears from the large quantity of vesicular neurine which they contain; and that the corpora striata are so, further appears from the absence of any correspondence in size between them and the hemispheric ganglia. Thus in fishes, we find that the corpora striata make up the principal bulk of the second pair of masses; in reptiles, birds, and the lower Mammalia, they still form a very large portion of that which is commonly termed the cerebrum; and their subordinate aspect in man and the higher Mammalia is solely due to the large relative development of the hemispheric ganglia. On the other hand, there is scarcely any rudiment of the thalami optici to be discovered in fishes; their proportional size increases in reptiles, birds, and the lower Mammalia; but it is only in man that their dimensions approach those of the corpora striata. The peculiar connection of the thalami optici with the posterior columns of the spinal cord, and their great development in man, suggest the idea that they are the ganglia of *tactual* sensation; whilst the connection of the corpora striata with the anterior columns indicates their relation with the motor function. The very close relation between the thalami optici and the corpora striata—corresponding, as Messrs. Todd and Bowman have suggested, with that which exists between the posterior and anterior peaks of gray matter in the spinal cord—harmonizes well with the fact that the greater number of muscular movements are directed by common sensation; whilst the special connection established

* On the Functions of the Cerebellum, by Drs. Gall, Vimont, and Broussais, translated from the French by George Combe, 1837.

by the inter-cerebral commissure between the corpora striata and the optic ganglia (tubercula quadrigemina) explains the peculiar influence of the sense of light in directing certain classes of muscular actions. The communication which is formed by the medullary substance of the cerebrum between these ganglia and the hemispheric ganglia seems to be the medium by which *sensations* are transmitted to the latter, to become the stimulus of intellectual operations, and by which the influence of *volition* is transmitted downwards to excite muscular motions through the corpora striata.

The whole chain of sensory ganglia is regarded by Dr. C. as not only the instrument by which sensations are received, but also as the centre of those *automatic* muscular movements which differ from those of a simply reflex character, in being dependent upon sensation. To this head, he refers the purely *instinctive* actions of the lower animals, as well as a variety of actions performed by the human being, both in health and disease; such as the consensual movements of the eyes, the regulation of the laryngeal muscles in the production of vocal sounds, the convulsive movements in hydrophobia, brought on by the sight or sound of water, &c. &c. And he considers the actions which become automatic by *habit*, as executed through the same channel; each movement being directly prompted by the sensation with which it has become associated.

We come lastly to those important ganglia which crown and cover in the rest—the hemispherical. If there is one point in the physiology of the brain more unequivocally demonstrated than another, it is that these ganglia are the instruments of the mind—the portion of the brain in which sensations are converted into perceptions, and give rise to ideas. Comparative anatomy; developmental anatomy; experiments on living animals; observations on its size and form, as indicated by the size and form of the skull; and last, but not least, pathology,—all afford a mass of overwhelming evidence that this portion of the brain, and this only, is the cerebral organ of intellectual power.

Müller, whose authority on all physiological subjects is interesting, after speaking of the general evidence in favor of a belief that the intellectual faculties reside in the cerebral hemispheres, says,* "It has, however, been proved by direct experiment that such is their seat. The experiments of Flourens are here also especially instructive, and Hertwig has in the essential points done no more than confirm them. The hemispheres are insensible both to puncture and incisions. That part of the brain in which the sensations are converted into ideas, and the ideas hoarded up, to appear again, as it were, as shadows of the sensations, is itself devoid of sensibility."

Further on, he says, "The experiments of Hertwig confirm M. Flourens' observations. Wounds of the hemispheres (in a dog) excited no pain, unless they extended to the base of the brain, when signs of pain were exhibited. M. Hertwig removed both hemispheres in a dog: the animal did not move from the spot voluntarily, but was thrown into a state of complete stupor; if irritated, it moved a few steps, and then

* P. 834, op. cit.

fell again to the ground in a sleepy state. It did not hear even the report of a pistol. M. Hertwig removed the upper part of the hemispheres in a pigeon; sight and hearing were abolished, and the animal sat in one spot, as if asleep. He fed it: peas, if placed merely within the beak, were not swallowed; but they were, if laid upon the tongue, owing to reflex action; the muscles were but slightly enfeebled; the bird stood firmly, and flew when thrown into the air. This state endured for a fortnight, when the hearing and sensibility in a great measure returned; this pigeon lived three months. A hen, in which Hertwig had cut away both hemispheres nearly to the base of the brain, was found to be deprived of sight, hearing, taste, and smell. It sat constantly in one spot, and was as if dead, until strongly roused, when it moved a few steps. The animal lived in this state of stupor, without its senses being restored, for three months. M. Schoeps has instituted similar experiments."

It is evident from these experiments, and from the effects of pressure on the cerebral hemispheres in man, that they are the seat of the mental functions; that in them the sensorial impressions are not merely perceived, but are converted into ideas; and that in them resides the power of directing the mind to particular sensorial impressions, the faculty of attention.

In considering the question, is the brain the organ of the mind? I must say, with Mr. Combe, that the physiologist "regards man as he exists in this world, and desires to investigate the laws which regulate the connection between the *mind* and its *organs*, but without attempting to discover the *essence* of either, or the manner in which they are united."

And, in connection with this subject, let us ever bear in mind that we are not *conscious* of the existence and functions of the organs by which the mind operates in this life, and, in consequence, many acts appear to us to be *purely mental*, which experiment and observation prove incontestably to depend on *corporeal organs*.

"For example, in stretching out or withdrawing the arm, we are conscious of an act of the will, and of the consequent movement of the arm, but *not* of the existence of the apparatus by means of which our volition is carried into execution."

"*Experiment* and *observation*, however, demonstrate the existence of bones of the arm, curiously articulated and adapted to motion; of muscles endowed with power of contraction; and of *three* sets of nerves, *at least*, &c."

"All that a person uninstructed in anatomy knows is, that he wills the motion, and it takes place: the whole act appears to him to be *purely mental*, and only the arm or thing moved is conceived to be corporeal. Nevertheless, it is positively established by anatomical and physiological researches that this conclusion is erroneous—that the act is not purely mental, but accomplished by the instrumentality of the various organs now enumerated. In like manner every act of vision involves a certain state of the optic nerve, and every act of hearing, a certain state of the internal ear; yet of the existence and functions of these organs, we obtain by means of consciousness no knowledge whatever."

Now the phrenologist, says Dr. Combe, goes "one step further in the same path, and states, that every act of the will, every flight of imagination, every glow of affection, and every effort of the understanding, *in this life*, is performed by means of cerebral organs unknown to us through consciousness, but the existence of which is capable of being demonstrated by experiment and observation; in other words, that the *brain is the organ of the mind*—the *material condition*, without which no mental act is possible in the present world."

"The mind *sees* through the medium of the eye, just as it *thinks* or *feels* through the medium of the brain; and as *changes* in the condition of the eye deteriorate or destroy the power of vision without any affection of the principle of mind, the obvious inference follows, that in like manner may changes in the condition of the brain destroy the power of feeling or of thinking, and yet the *mind* itself, or *soul*, remain essentially the same."

The most decisive facts in proof that it is the surface of the brain or the hemispherical ganglion which directly ministers to intellect, are derived from pathology, and especially the consequence of inflammation of the membranes, as we shall see when we consider the diseases of the brain. The varying effects of apoplexy afford also strong evidence in favor of this opinion. I will very briefly state the argument now. If the effusion of blood take place on the surface of the brain, the mind is more or less disturbed, and if the effusion is extensive, the intellect is buried for ever; but if the effusion is limited to the medullary substance, the mind, having recovered the first effect of the general shock, remains perfect, though its conducting instruments are paralyzed.

The first philosopher who attempted to prove that the brain does not minister to the intellect as a single organ, but as a combination of organs, was Gall; and I think he deserves the gratitude of mankind for his labors, though all his views may not ultimately prove correct.

The science which Gall advocated is now well known under the title of phrenology. Those who have not given their serious attention to this subject have a sort of indefinite idea that phrenology is some occult science, by means of which its professors pretend to be able to judge of a man's character by an examination of the bumps upon his head. This is the phrenology of the superficial and the idle, who, not having industry enough to investigate for themselves, set up a baseless shadow, and then take credit for the facility with which they overthrow it. This is not the science of phrenology, but the phantom of their own imagination. In the first place, the term bump, in reference to the surface of the skull, has no place in the vocabulary of the phrenologist. The practical phrenologist judges of character by space rather than by mere elevation or depression.

It must always be borne in mind that the physiological principles upon which phrenology is founded, may be perfectly correct, and nevertheless its professors may make great mistakes in their application.

Spurzheim himself says, "The true principles of a science may be established, but those who apply them may err."

"The art of surgery is positive, yet there cannot be a doubt but that legs have been amputated which might have been saved, and in the

practice of their art all surgeons have not the same dexterity. Every physician has not equal facility in distinguishing disease; the healing art nevertheless exists."

"I do not conceive that phrenology has reached perfection now [1826], nor do I expect that its application, even when perfect, will always be without error. I have been frequently obliged to rectify my judgment, but I always endeavor to profit by my mistakes."

Those who really wish to understand phrenology, and judge of its correctness, ought to read the works of Gall, Spurzheim, Combe, and, lastly, the admirable treatise of Mr. Noble; for arguments on the other hand they should also peruse a critique of the last-mentioned work in the British and Foreign Quarterly Medical Review, vol. 22; in which the writer most ably advocates the necessity of employing comparative anatomy in the study of cerebral physiology.

My reasons for believing that there must be a great deal of truth in phrenology are fourfold. First, I have received from practical phrenologists, and especially the late worthy Mr. Deville, such accurate characters of individuals known to me, but unknown to them, that I cannot believe the accounts I received could be the result of accident and conjecture, which must have been the case if phrenology is untrue.

Secondly. Phrenology alone—as it appears to me—can account for all the varieties of insanity, especially monomania.

Thirdly. The facts which have been collected by the late Mr. Deville, showing that the brain will alter its form at any period of life.

Fourthly. The existence of longitudinal commissures.

In Mr. Deville's collection there are above twenty casts which prove an alteration in form; as far as I am able to judge, they correspond with the mental and moral exercise which the brain experienced in the period during which the changes were taking place. Few medical men are aware of the immense number, and the importance, of the facts established by that collection; and whether phrenology is true or false, such a collection should not be lost to the nation. The government has been most liberal in granting sums for the purchase of antique marbles and specimens of natural history for the British Museum—all important objects for the improvement of the people; and they would confer a lasting benefit to science, and, through it, to the nation at large, were they to add this to our national treasures.

If phrenology is true, insanity on its first ingress is frequently not a disease of the whole brain, but of only a part of it. The first effect of inflammation is to excite to an unnatural degree the natural function of an organ. The function of the organ thus exalted obtains a mastery over the rest. For instance, a man, from defective education, combined with hereditary tendency, allows his love of approbation, his vanity, in other words, to grow with his growth, and strengthen with his strength, gradually becoming the sole ruling principle of life: at last it, instead of reason, so completely guides and regulates all his actions, that they are contrary to reason, and justly called the acts of a lunatic. Yet all this may go on with reasoning faculties so acute, that he conceals the dominant feeling of his breast, the mainspring of all his actions, and in a court of law defies any one to prove him insane.

The great amelioration which has been effected in the condition of the lunatic has been founded on this principle, that none are so mad as to be incapable of appreciating kindness. Throughout all the admirable and interesting reports of Dr. Conolly, it will be seen that this has been the guiding principle of his boldly humane treatment. The first thing, says this admirable man, is to gain the *confidence* of your patient; and that once obtained, you may do *anything* with him.

Now if this is true, (and no one who has treated the insane on these principles doubts it,) so is it equally true that they may be awed by punishment and even acknowledge its justice. Only the last time I had the pleasure of visiting that noble asylum, Hanwell, I listened with much interest to a lunatic whom we met in the grounds. He began by requesting Dr. Conolly to procure his release from the Asylum, and then went on in a rambling manner, reasoning on things and circumstances which had no existence, showing his mental aberration; but he finished by saying, as an argument for his being allowed his liberty, *that he had always conducted himself with propriety* while there, which was perfectly true. This sense of right and wrong was as perfect as ever, and this sense enabled him to conduct himself properly. But if we had supposed that the circumstance of his being lunatic gave him a license for any conduct, and freed him from all responsibility, would he have been so anxious to conduct himself properly? And if he were told that the law of the land would not take notice of an improper act, even if that act amounted to the murder of a fellow-creature, he would not feel the same reason for self-control.

Mental philosophers have always admitted that if a man through imperfect education has never had his reasoning faculties called forth, the instrument of that power becomes more or less atrophied, and the power is more or less lost. For instance, take two boys born of the same parents, and with the same or nearly the same original capacity; suppose them differently educated, the one brought up in the fields, and all mental culture neglected, the other trained for a learned profession. When these two have arrived at maturity, oblige them to change places, and the incapacity of the brain of the peasant would only be surpassed by incapacity of the muscular system of the student. The same applies to moral as to intellectual culture. And hence the same importance of early education for the formation of moral strength as for the formation of intellectual or muscular strength. But phrenology goes further than merely to insist on the importance of educating the child. It goes further also in tracing moral insanity to its real cause. It teaches us that the child inherits more or less of the mental or moral capacity of the parent, just as much as he inherits the form of the face and physical constitution. And as personal beauty may be more or less spoiled and effaced by evil education, (and I refer to the moral and mental education of circumstances and example,) so may the brain, with its mental and moral faculties, be deteriorated and debased by the same causes. But phrenology also inculcates that, although it has pleased the Almighty, for some good and wise purpose, to ordain that not merely the bodily diseases of parents, but even their mental and moral imperfections, shall more or less descend to their children, such hereditary imperfections,

whether of the intellectual, the muscular, or the mental organs, may be corrected by careful attention.

It has not been my object so much to prove the truth of phrenology, as to show that, if true, the following must also be so—that though the form of the brain is not alike in all children at birth, any more than their dispositions or intellectual capacities are alike, the form of their brain may be altered and improved, as the disposition and the intellect may be, at any period of life, by education and restraint.

Lastly, with regard to the office of the *commissures*, this is implied in the name by which they are known. The structure of these parts, their comparative anatomy, analogy, and the few pathological facts that have been recorded, bear us out in the view I have taken of their office as conductors of nervous power, as the media of establishing communication between one portion of the encephalic mass and another, and, in this way, intimately connected with the faculty, possessed by man especially, of comparing and reasoning upon the various impressions received by the different portions of the hemispheres.

PART XI.

DISEASES OF THE BRAIN.

In undertaking this division of my subject, I am afraid that by some I shall be considered as stepping beyond the proper boundaries of surgical practice. To such I must observe that every surgical disease requires more or less of medical treatment; that no surgeon is competent to treat an injury of the head affecting the brain, who is ignorant of cerebral pathology; that the distinction between medicine and surgery is artificial; and that a distinction between diseases arising from external violence and from internal disease is false and mischievous. One of the first principles instilled into my medical mind by my respected master, Mr. Travers, was the necessity of studying medicine at the hospital with the same diligence and attention as surgery. The interest I have felt from the time I first heard Spurzheim demonstrate the brain in 1826 has induced me to attend to the pathology of this subject more than perhaps I should otherwise have done. These observations are made, not to prove fitness for the task I have undertaken, but simply to explain that I do not allow that the fact of my practising as a surgeon is any excuse of incompetency.

For many years I have thought much upon the functions of the brain, and endeavored to observe the phenomena which attend the disturbance of those functions. In detailing the information I have obtained by observations and reading, I must rely on the same kind indulgence for the imperfect execution of my task, which has been so liberally accorded to my former labors.

In this outline of the diseases of the brain, the following arrangement will be adopted:—

1. Anæmic affections.
2. Hyperæmic.
3. Convulsive.
4. Organic.

This arrangement, like every other that has been adopted, is of course liable to objections. Each of these affections will occasionally run one into the other, so that the lines of distinction are lost; nevertheless, in a practical point of view, I hope it will on the whole be found advantageous.

I have not divided the history, diagnosis, and treatment of these diseases so strictly as some authors have done. My reason for which is, that it is impossible to maintain these divisions, if the subject is much

illustrated by cases; and I believe that the interest of the reader is more continuously kept up by mingling them together.

Before we consider these different affections separately, it will be advisable to determine, as far as possible, whether the quantity of blood within the cranium ever varies, and whether the cerebral substance can be compressed. The student who has seen something of disease practically, and is conversant with the expressions which the practical physician employs, but who is not well acquainted with the literature of medicine, will be astonished that these points should have been ever questioned. It has, however, been questioned, and the result is, that for some years it was admitted, as an established doctrine of physiology, that the quantity of blood in the cranium never varies, and that the brain is incompressible. It will be necessary to show here the grounds upon which they are now abandoned. The theory has had a mischievous tendency in a practical point of view; for instance, Dr. Clutterbuck, in his article on cerebral apoplexy in the Cyclopædia of Practical Medicine, says, that "no additional quantity of blood can be admitted into the vessels situated in the brain, the cavity of the skull being already completely filled by its contents. A plethoric state, or over-fullness of the cerebral vessels altogether, though often talked of, can have no real existence; nor, on the other hand, can the quantity of blood within the vessels of the brain be diminished: no abstraction of blood, therefore, whether it be from the arm or other part of the general system, or from the jugular veins (and still less from the temporal arteries), can have any effect on the blood-vessels of the brain so as to lessen the absolute quantity of blood contained within them."

I cannot conceive a more dangerous doctrine in the practice of medicine, particularly coming from such an authority as Dr. Clutterbuck, and one who is generally so fond of bleeding. The profession is indebted to Dr. George Burrows for dispelling these illusions.

Monro Secundus, of Edinburgh, is generally believed to have been the first who propounded this doctrine. He observes,* "As the substance of the brain, like that of the other solids of our body, is nearly incompressible, the quantity of blood within the head must be the same at all times, whether in health or disease, in life or after death, those cases excepted in which water or other matter is effused or secreted from the blood-vessels: for in these cases a quantity of blood, equal in bulk to the effused matter, will be pressed out of the cranium."

Monro regarded the skull as if it were a perfect air-tight sphere, uninfluenced by the pressure of the atmosphere; and he used to illustrate his theory by showing to his class a glass ball filled with water, which he inverted to show them that not a drop of water would escape through the aperture.

Abercrombie, who supported this view, does not appear to have instituted any positive experiments, but to have founded his opinion on the experiments of Dr. Kellie, published in vol. i. of the Transactions of the Med. Chir. Society of Edinburgh.

Dr. Burrows first promulgated his valuable and conclusive researches

* Observations on the Nervous System, Alex. Monro, M. D., 1793.

on this subject in his Lumlean Lectures, delivered at the College of Physicians, March, 1843, published in the thirty-second volume of the Medical Gazette, p. 146, and to them I must refer my readers for a full exposition of the opinions of preceding observers, their experiments, and the conclusions they draw from them. Dr. Burrows has since entered more fully into the subject in his admirable work entitled "On Disorders of the Cerebral Circulation," &c., 1846. The following experiments which he first made are so decisive of the question that I cannot help quoting them in full:—

"On the 11th of January, 1843, I killed two full-grown rabbits. The one (A) by opening the jugular vein and carotid artery on one side of the throat; the other (B) was strangled. Each animal died violently convulsed. A ligature was drawn tightly round the throat of the rabbit (A) immediately it expired, to prevent any further escape of blood from the vessels of the head. The rabbits were allowed to remain twenty-four hours on a table resting on their sides. While the blood was flowing from the rabbit (A), the conjunctiva was observed to become pallid, and the eyeballs to shrink within the sockets. Upon the examination of the head of the rabbit, the integuments and muscles appeared blanched and exsanguine. Upon removing the upper portions of the cranium, the membranes of the brain were found pallid, and scarcely the trace of a blood-vessel was to be detected on the surface of the brain. The longitudinal and lateral sinuses were nearly empty of blood, and their course was not denoted by any color of blood. Upon making sections of the brain, the interior appeared equally exsanguine.

"Soon after the cord was drawn tight round the throat of the rabbit (B), the conjunctiva became congested, the eyeballs turgid, prominent, and even projecting beyond the margin of their sockets. The integuments and muscles of the head were found full of blood. Upon opening the cranium, the superficial vessels of the membranes, as well as the sinuses, were full of dark liquid blood. The whole substance of the brain and its membranes appeared of a dark reddish hue, as if stained by extravasated blood.

"The contrast between the two brains on the point of vascularity, both on the surface and in the interior, was most striking. In the one, scarcely a trace of blood-vessel was to be seen; in the other, every vessel was turgid with blood. It seems hardly necessary to bring forward further evidence to prove that death by hemorrhage has a most decided effect in depleting the vessels and reducing the quantity of blood within as well as upon the outside of the cranium.

"I have, however, repeated the experiments with similar results. In fairness to Dr. Kellie, I should state that I have attended at the slaughtering of sheep by butchers, and find the brains of those animals much less depleted than the brains of rabbits which have died by hæmorrhage. But the sheep did not die from simple loss of blood, but partly from the division of the pneumogastric nerves and cervical portion of the spinal cord. These lesions no doubt influenced the appearances.

"Hence it is not a fallacy, as some suppose, that bleeding diminishes the actual quantity of blood in the cerebral vessels. By abstraction of blood we not only diminish the momentum of blood in the cerebral

arteries and the quantity supplied to the brain in a given time, but we actually diminish the quantity of blood in those vessels. Whether the vacated place is replaced by serum or resiliency of the cerebral substance under diminished pressure, is another question, into which I do not now enter."

Dr. Burrows also made experiments to decide whether position could affect the condition of the vessels within the skull; for Dr. Kellie had asserted that the quantity of blood in the cerebral substance is not affected by posture, and details experiments in order to prove it.

Dr. Burrows says, "On the 28th of December, 1842, two full-grown rabbits were killed by prussic acid, and, while their hearts were still pulsating, the one (C) was suspended by the ears, the other (D) by the hind legs. They were left suspended for twenty-four hours; and, before they were taken down for examination, a tight ligature was placed round the throat of each rabbit, to prevent, as effectually as was possible, any further flow of blood to or from the head, after they were removed from their respective positions.

"In the rabbit (C) the whole of the external parts of the head, the ears, the eyeballs, &c., were pallid and flaccid; the muscles of the scalp and bones of the cranium were also remarkably exsanguined. Upon opening the cranium, the membranes and substance of the brain were pallid, the sinuses and other vessels were exsanguined; anæmic beyond my expectation.

"In the rabbit (D) the external parts of the head, the ears, eyeballs, &c., were turgid, livid, and congested. The muscles and bones of the cranium were of a dark hue, and gorged with blood, which at some parts appeared extravasated. Upon opening the cranium, the membranes and vessels were dark and turgid with fluid blood; the superficial veins were prominent, the longitudinal and lateral sinuses were gorged with dark blood; there was staining of the tissues, if not extravasation of blood into the membranes. The substance of the brain was uniformly dark, and congested to a remarkable extent."

"Dr. Kellie asserts, but I think his experiments do not support him, that the contrast in the appearances within the heads of the two animals was but trifling. In my analogous experiments the contrast was most striking. In the one was to be seen a most complete state of anæmia of the internal as well as external parts of the cranium; in the other a most intense hyperæmia or congestion of the same parts; and these opposite conditions in the vascularity of the brain induced solely by posture and the gravitation of the blood."

"If the cranium were the perfect sphere, as taught by Monro, and as subsequently maintained by Abercrombie and other distinguished writers on the pathology of the brain, these effects on its circulation (which I have now exhibited) ought not to have resulted from the force of gravity on the blood in the cerebral vessels."

When Dr. Burrows first promulgated his opinions on this subject, he was obliged to combat the authority of Dr. Watson, among other men of note. It is, therefore, satisfactory to find this excellent physician now giving in his allegiance to these views. Indeed, it may be asserted

that they are now admitted by nearly all men as established principles in physiology.

Anæmic Affections.—During the last twenty years, much has been done in cerebral pathology, but in no section of it has so much progress been made as in the anæmic affections. At one time, coma was considered an unerring sign of pressure on the brain, and delirium an equally certain indication of inflammatory mischief; but it is now well known that both may arise from anæmia, either local or general.

The occurrence of serious symptoms from a diminished supply of blood to the brain is not universally admitted, but it is still a matter of dispute with some, whether these symptoms are occasioned by *diminished pressure* on the brain, or by a *smaller quantity of blood* within the cerebral capillary system.

Dr. Burrows, in the lectures already referred to, says that he is inclined to the opinion that some of the most remarkable symptoms arise rather from insufficient vascular pressure than from an insufficient quantity of blood in the substance of the brain. With all due deference to this admirable observer, I am inclined to an opposite opinion. We know that the function of all other organs, uninfluenced by pressure, may be excited by a flow of blood into them, or their function may be arrested by any stoppage in their supplies. Take the salivary glands or the testicles, as an illustration: mental emotions will both excite and arrest their secretions; and I believe that the brain would be similarly affected, and to the same extent as now, even if that organ were not enclosed in a spherical box, and supported on all sides by the cerebro-spinal fluid.

The effect upon the sensorium, of *suddenly* cutting off the supply of blood to the brain, is strikingly exhibited in the familiar instance of syncope, whether induced by loss of blood or mental emotion. Now it appears to me contrary to all analogy that the function of an organ like the brain (clearly as dependent as any other organ in the body on the blood for its power, or why should it receive so very large a proportion of the whole circulating quantity?) should be arrested by a mere change in its *physical* condition. The maintenance of such a doctrine appears to me to partake of the old leaven, which Dr. Burrows has so admirably upset.

Sir Astley Cooper, by his experiments with ligatures on the carotid and vertebral arteries of dogs, showed the dependence of the brain on its supply of blood for the performance of its functions. The first effect of pressure on the carotid arteries was to produce a state of partial insensibility: if the pressure was continued, then the animal lost apparently all consciousness. By pressing on the vertebrals as well as the carotids, life was very soon extinguished; the respiratory centres receiving their supply of blood from the vertebral arteries.

In the human being, the surgeon has occasionally an opportunity of observing the effect upon the brain of cutting off a portion of its supply of blood by a ligature on the carotid artery. It is true that sometimes a ligature is thus applied, and no sensible impression produced upon the sensorium, but more frequently there is an immediate, though it may be a temporary, effect produced. In other cases, the remote consequences are serious. Dr. Norman Chevers has published, in the Medical

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Gazette, vol. xxxvi. p. 1140, October 31, 1846, an admirable summary of the cases in which these vessels have been tied, and he has exposed the danger to which the brain is subjected by this proceeding, showing that the danger of the operation is not confined to its performance. The whole paper is worthy of perusal—but I must confine myself to some of his deductions. He says, that though by far the larger proportion of those in whom the primitive carotid artery on one side is obliterated, recover, a considerable number become hemiplegic, and perish from disease of that hemisphere of the brain. The conclusion that obliteration of one carotid artery is never liable to be followed by impairment of the cerebral functions, must therefore be discarded.

"(1.)—The form of disease found in the brain after death in several cases related above," says Dr. Chevers, "was of a kind which is generally considered to depend upon local anæmia, not upon congestion.

"In some of these instances, signs of deficient supply of blood in the side of the brain to which the obstructed artery passed, were strikingly apparent.

"The parts of the cerebral substance which were principally involved in disease, were those supplied by the chief branches of the obstructed vessel.

"Obliteration of the internal jugular vein was not observed.

"(2.)—There were not remarked any morbid appearances to indicate that inflammation had been conveyed backwards along the nerve to the brain. The part from which the par vagum arises is not shown to have been involved in the disease. That cerebral disease may be established in these cases quite independently of implication of either the vein or the nerve, is further proved by the facts that the paralysis has been known to occur almost immediately after the artery has become obliterated, before inflammation could be possibly established in the surrounding parts: and that organic lesions of the brain present themselves in cases where the vessel has become gradually obliterated by processes which are confined to its interior, and do not at all involve adjacent structures; that although persons in whom the carotid is tied may suffer from slight cerebral symptoms, and yet perfectly recover, those who become completely hemiplegic have barely a chance of surviving."

Dr. Chevers sums up with this excellent practical observation:—"The facts adduced in this paper, it is submitted, prove that the danger of cerebral disorganization should have its weight in the consideration of cases where it is proposed to secure the common carotid artery, not indeed as rendering at all doubtful the propriety of the operation in the majority of the cases in which it is at present had recourse to, but as strongly discountenancing it in nearly all instances where the disease for which it is employed does not positively threaten the patient's existence, and in every case where other means of treatment can be employed."

Dr. Burrows, whose opinion on all practical subjects is of the highest value, suggests the application of a ligature to the carotid artery in some cerebral affections. He says,* "In violent and hopeless cases of

* P. 78, op. cit.

epilepsy, and some kindred maladies which are characterized by extreme cerebral congestion, it appears to me that, other remedies failing, this operation may be fairly resorted to. I am aware of the responsibility of advocating a remedy attended with risk to life; but are not all our best remedies most violent poisons in the hands of the unskillful?" I quite concur with Dr. Burrows in this opinion, and more particularly as the operation has been successfully performed for epilepsy—as related further on.

Surgical operations and accidents are not the only agents which produce an anæmia of the brain, local or general.

The balance of the circulation may be disturbed by various causes, but there is none so frequently observed as that arising from the intemperate use of stimulating drinks.

Their primary effect is to excite the heart's action to unnatural exertion; all the organs feel this, but the brain more than the rest: after a storm comes a calm. The intervals between the use of these stimuli are the calms; but unlike the calms of Nature's hand, they are states of fearful depression. When these intervals are long continued, they are not merely states of depression, but states of delirium; and this leads us to the consideration of that frightful, and, if it were not for the feelings of pity which arise from the contemplation of a human being degraded below the level of the brute, we might add, disgusting and horrible malady, delirium tremens. Delirium ebriosorum I regard as a distinct disease, an hyperæmic affection, as will be explained a little further on.

Delirium Tremens.—I believe that we are justified in classing delirium tremens under the head of anæmic affections of the brain. It is true, that our pathological records of this disease are very scanty; but in all the cases which I have had the opportunity of examining after death, I have invariably found the hemispherical ganglion, or cortical substance, pale and bloodless; the venous canals were generally full; and occasionally the arachnoid thickened, as if it had been the subject of chronic inflammation. It is curious that so well as the treatment of delirium tremens is now understood, it is comparatively only a few years since it was first described in print. The late Dr. Thomas Sutton, of Greenwich, first gave it its present title, and distinguished it from phrenitis. He says,* "Delirium tremens, and likewise the treatment, which will be pointed out as we proceed, are known to some professional men to a certain extent; but to many they are wholly unknown: and the disease has not yet taken a station in medical writings. Dr. Wm. Saunders, late physician to Guy's Hospital, and for many years lecturer on medicine at that hospital, whose opinion I had the advantage of obtaining on this tract, considered the assertions in this paragraph to be perfectly correct; but stated to me, that he had mentioned the disease alluded to in his lectures for many years, and had been in the habit of noticing and distinguishing it from phrenitis during forty years of his practice. So far as my observations and inquiries have gone on this point, its treatment

* Tract on Delirium Tremens, by Thomas Sutton, M.D., of the Royal College of Physicians, late Physician to the Forces, and Consulting Physician to the Kent General Dispensary, 1813, p. 3.

is acknowledged by only a few, who have not collected any very ample information on the subject." The Dr. does not add to our knowledge of the pathology of the disease.

Dr. Copland, whose article on this subject, like all contained in his admirable Encyclopædia, is copious and erudite, merely says, "The appearances on dissection have furnished only negative information as to the nature of the disease." He speaks of "slight opacity of the arachnoid, especially at the base, a little injection of the pia mater, a little fluid in the ventricles," but not one word about the condition of the cortical substance of the brain.

Dr. Blake* says, "When this disease terminates fatally, it does not seem to me to be owing to venous congestion, as the late much-to-be-lamented Dr. Armstrong asserted in his valuable work, or to inflammation of the brain, as Dr. Clutterbuck mentions in his lectures in the Lancet, vol. ii. p. 376. I would ascribe it to serous effusion within the cranium—every *post-mortem* that I have since witnessed in cases of pure delirium tremens, tended to confirm me in these sentiments."

This author makes an excellent practical observation, to the correctness of which I can add my testimony, and which bears out my view of the anæmic character of this disease. The stimulus of light, or indeed of any excitant, seems of advantage in delirium tremens; but not so in the commencement of mania: its symptoms are invariably exasperated by such influence.

Many authors have divided delirium tremens into two kinds, but, as I have long thought and taught, erroneously. They have, in fact, confounded that delirium, *delirium ebriosorum*, which may be excited in any individual by the use of stimulants, with the true delirium tremens, which is alone produced by the sudden withdrawal of a long-continued use of them. The one depends on a congested state, the other on an anæmic condition, of the hemispherical ganglion. Entertaining these opinions, I was much pleased to find it thus treated by Dr. Blake.† Correct views on this subject are essential to a right understanding for practical purposes, of many other diseases of the nervous system. I suspect many forms of Hysteria are dependent on a similar anæmic condition of the brain, though the cause producing it is so widely different.

Dr. Blake regards them as distinct and opposite diseases, the one being the immediate consequence of intemperance, the other arising from the sudden cessation of accustomed intemperate stimulation—the one requiring the cautious use of depletion, the other the administration of stimuli—the one belonging to the class phlegmasiæ, the other to that of neuroses. In illustration of the distinction of the delirium which *immediately* follows indulgence to excess in spirituous liquors, and that which does not come on until after a cessation of intemperate habits, he relates a case of a man who was an habitual tippler, and whenever he exceeded his usual allowance, which was tolerably often, he was attacked with furious delirium, and which, if not cautiously treated,

* A practical Essay on the disease generally known under the denomination of Delirium Tremens, &c., by Andrew Blake, M. D., M. R. C. S., &c., 1840, p. 58.

† P. 64, op. cit.

was followed by a consequent stage of exhaustion, and, in due time, by all the stages of delirium tremens.

This peculiar idiosyncrasy of constitution, by presenting both diseases successively in the one subject, serves to point out clearly the difference which exists between the delirium consequent upon the *immediate* effects of spirits, or other diffusible stimuli, and that which succeeds in one, two, three, or more days, as the consequence of suddenly desisting from the habitual abuse of any stimuli.

In the cases of delirium tremens which we have in the surgical wards of the hospital, the disease generally comes on in patients who have met with some severe injury, such as fracture of one or more of the extremities, injuries of the head, &c., and whose habits are extremely intemperate. Many of these miserable drunkards are in the habit of swallowing more than a gallon of beer in the day, with a certain amount of gin to carry it off by the kidneys. On their admission into the hospital, of course the enormous supplies are cut off, though we generally ascertain what are the usual habits of our patients, and give them a little extra to the ordinary house allowance. But a pint of beer extra is a mere drop in the ocean compared to their usual quantity, and in a few days we often observe a slight tremor of the tongue *when protruded.* There is a wildness about the eye, an unnatural quickness of manner when answering our questions. The sister of the ward tells us that during our absence he is very busy pulling the bed clothes, perhaps rolling up his upper sheet. The tongue is not unusually dry or furred, as in phrenitis; the skin is bathed in sweat; the pulse is quick and irregular, both in force and frequency. Now if we do not take the hint of the storm which is threatened by these premonitory symptoms, we find our patient in a state of raving delirium in the course of a very few hours, and woe to the fracture.

Dr. Watson, whose description of all disease is so graphic and so correct, and who has seen it more frequently than I have had the opportunity of doing, unconnected with a confinement to bed by local injuries, says, "The delirium you will generally find to be, not a fierce or mischievous delirium, but a busy delirium; he does whatever you desire him to do, but he does it in a hurried manner, with a sort of anxiety to perform it properly. During the approach of the malady, while he is yet able to go about, he manifests great impatience of any interference, or advice, or assistance in his ordinary duties, which he sets about in a bustling and blundering manner. His loquacity is extreme, and he refers to matters that are not present before him; he is not altogether inattentive to the objects and proceedings that are going on around him, but his mind wanders away to other subjects. There is an odd mixture of the real and the ideal in his thoughts and language. Sometimes he is very suspicious that those who are about him intend him some injury; or that he is surrounded by enemies. You will find also that he does not sleep, that he has not slept perhaps for several nights, but been restless and rambling; and you will generally learn that he has been habitually intemperate, or subject to some great source of care, or anxiety, or excitement: and in many cases he has been recently, somehow or other, debarred from his customary stimulus. In addition to these points

in his history, you will frequently be told that having been unwell, first he has been kept upon low diet, and then, as the delirium came on, he has been freely bled, and that he has been none the better, but commonly the worse for the bleeding. When you gather such particulars as these from his friends (for upon his own statements you cannot place any reliance), and when you find the delirium to have the character I have been attempting to describe, and especially when there has been obstinate watchfulness, and the tongue is moist, and the skin is sweating, you may be pretty certain that your patient is affected, not with inflammation of the brain, but with delirium tremens; and that if you bleed him further you will make him worse." Sometimes the pathological condition which excites delirium ebriosorum is an inflammatory action of a low character occurring in a constitution much shattered by long-continued debauchery. In these cases it is necessary to support the system with the accustomed fermented liquors, and employ local counter-irritants to the head, with diuretics, to prevent serous effusion. The following history illustrates this class of cases:—

Case 1.—Coulson Johnson, æt. 47, waterman on cab-stand, countenance bloated, admitted into George's Ward, under my care, January 12th, 1847, with simple fracture of the thigh, about the middle third. It was very loose, and he complained of much pain. He appeared as if he had been drinking, and his face was flushed and skin moist. Pupils dilated. Appeared inclined to sleep, and does not answer questions readily. His breath was very foul. When in bed his teeth chattered from cold, and so he continued for some time.

Was put up in splints for the night.

Jan. 13th. Has passed a restless night, and complains of much pain. Pulse quick and full. Skin moist, but he says he is very cold. Tongue and breath foul. Restless. Put up in the straight splints—great difficulty in doing so, owing to his drawing the limb up. Says he has been used to drink freely. Mr. Green saw him, and ordered Opii gr. j. statim. Towards night he was quiet for a time after the opium, but at 8 P.M. wanted to get out of bed, and was noisy but not violent. Vespere. Mr. Whitfield ordered him, Sol. Morph. Mur. ♏xx. Ammon. Carb. gr. v. ex. Mist. Camph. 6tis. Gin ℥iv. Pulv. Rhei. c. Hydr. ℈j. stat.

14th. Is no better. Passed evacuations and urine in bed this morning. Dozes off occasionally, awakes, and is restless, and then dozes again for a time. Answers questions when roused. He removed all the apparatus from his thigh.

15th. Much the same. Removes his apparatus, and the handcuffs were put on him. I saw him for the first time to-day. The symptoms were very obscure; there was more coma and less tremor than we generally meet with in delirium tremens. But the cold surface, sleeplessness, contracted pupils, and weak pulse, determined me to give him porter; at the same time I thought it safe to add some tinctura Lyttæ to his medicine, in order to excite the action of the kidneys and avert serous cerebral effusion, of which there was some threatening. Porter, 2 pints; Tinct. Lyttæ ♏xv. e. Mist. Pupils contracted. Gets no continued rest.

16th. No better; 4 pints of porter.

17th. Is decidedly better for the extra porter; but as he has diarrhœa, and passes motions in bed, I feel obliged to omit the porter, and order Træ. Opii ♏x. Mist. Cretæ Co. ℥j. 6tis. Brandy ℥iv. daily.

18th. A little better. Has not passed evacuations since. Is restless towards night. Pulse slower.

20th. His hands having been unfastened, he undid all the apparatus during the night.

22d. Sol. Morph. Mur ♏xl. e. Mist. 6tis. Continues in much the same state.

26th. No better; but with rather more tendency to coma. Hyd. c. Cretæ gr. ij. o.n. Træ. Opii 6tis. horis—Empl. Lyttæ pone aures.

27th. Apparatus put up once more.

28th. Is better for the blister. Has been quiet since yesterday, and answers questions more rationally.

30th. Still better. Answers questions perfectly—remembers the circumstances of the accident—but not his pulling the splints off. Does not pass evacuations in bed. Porter ilb ſs.

Feb. 1st. As bad as ever. Removed all the splints again, but answers questions, and declares he does not meddle with the apparatus, but that the other patients do. In this state

he continued until February 10th; his hands muffled night and day. Takes his drink and asks for more. He was tried for a day without the gin, but soon became worse for that. Empl. Lyttæ p. aur.

16th. Rather better. One hand let loose, when he immediately removed the splints; talks rationally except at night, when he calls out on people whom he has seen in the day, and sometimes is very noisy. Pulse natural. Evacuations not passed in bed.

20th. Put up in pasteboard splints to-day. The stimulants were continued, and he gradually recovered, but with weakened intellects.

Judging from the cases of delirium ebriosorum, which are even now occasionally published in the medical periodicals as cases of delirium tremens, I am afraid that this distinction is not sufficiently attended to. The diagnosis is often very difficult, but I have almost always found that when large doses of opium fail in producing sleep, we ought to consider that the case is one of hyperæmia, and not anæmia, and if we change the treatment, relieving the congestion of the brain, sleep soon follows. It is better to avoid the use of all blood-letting if possible, and never to abstract it except locally. Leeches and the cupping-glass are the best agents. A warm-bath for the whole body, and cold to the head, either by means of a stream of cold water or pounded ice, prove much better narcotics than all the varied forms of opium, in delirium ebriosorum. If these means do succeed, their success establishes the nature of the case, and ought to guide our future treatment, as explained further on in the section on chronic meningitis. These cases are often very obstinate, and require great patience on the part of both patient and surgeon. They often ultimately terminate with more or less mental debility. The last case of this kind which I had under my care was a retired naval surgeon; he nearly recovered from the corporeal disorder, but I fear that his mental energy is so weakened, that he will return again to the fatal source of his disease.

It is impossible to give in words, all that distinguishes these two diseases; they must be seen frequently to be appreciated. But the following will assist in their diagnosis. The head and skin generally is cool and moist in delirium tremens, dry and hot in delirium ebriosorum. The pupil varies in both according to the stage: in the early stage of both it is generally contracted, in the latter stage dilated. The conjunctiva injected and red in delirium ebriosorum; the reverse in delirium tremens. The mental derangement in the former is more allied to an exalted, excited state of intellect; in the latter it approaches fatuity and depression. The tongue is generally pale and furred in delirium tremens, sometimes unnaturally clean and red; in delirium ebriosorum is usually dry, and sometimes brown, but this is no certain guide. The pulse is most uncertain, for as all inflammatory affections of the brain are depressing in their effects on the heart's action, so do we find that the pulse is not hard and wiry in the hyperæmic affection, which, however, never amounts to one acutely inflammatory. Still, on the whole, there is less power in the beat of the artery, and that more varied in delirium tremens than in delirium ebriosorum.

The danger attending an error in diagnosis in such cases is evident, for if we omit to recognize the inflammation of delirium ebriosorum, only a few days need elapse to render such inflammation fatal; and even in those cases in which all the signs of delirium tremens are so clearly

present that we cannot mistake them, we have to bear in mind that though delirium tremens is not an inflammatory disease, that the excessive and constant use of stimulating liquors does predispose the membranes of the brain to inflammation, and that the two diseases frequently run one into the other.

The plan of treatment which I have found on the whole most successful in true delirium tremens, is to give the stimulus which the patient prefers from being most accustomed to: this is usually porter and gin, in the hospitals; brandy or wine, or both together in private practice. And revolting as it is to our feelings as moral beings to pour in the very poisons which, by their habitual use, have reduced the man to the level of the brute, still, as medical men, it is our duty to preserve life by those means which we know are capable of doing so.

Often have I been obliged to go on increasing the quantity of porter from one pint up to four or even five ; and gin up to twelve and sixteen ounces. I always combine with it opium and ammonia. I much prefer the tincture of opium to any other preparation, as being more certain and more rapid in its action. I give thirty drops with a drachm of the spiritus. am. aromat. in camphor mixture every four hours, and a drachm of the tincture at night, to be repeated if it does not produce sleep in two hours.

If there is much irritability of stomach, I then give it in a state of effervescence.

I have had no experience of anodyne enemata, as recommended by Dupuytren, but I should not hesitate to employ them, if the oral exhibition of opium failed.

As soon as the stomach will retain any food, it must be given. Patients will often take soups and broths before solids; but whatever is given should be highly nutritive.

Generally speaking, I find this plan successful. Where it has failed, it has generally done so because it has not been adopted early enough, and the stimulus has not been given in sufficiently large quantities, or the patient has been an old man, whose constitution had been worn out by long-continued intemperance and repeated attacks of this awful complaint.

Dr. Blake says,* and I agree with him, "The state of the pulse, though not always an infallible guide in disease, has been to me a comparatively sure one in this complaint, as when its frequency did not exceed one hundred strokes in the minute, I looked on the patient, generally speaking, as safe; but on the contrary, when, from its rapidity, and the tremor of the hands, it could scarcely be counted, I considered him in imminent danger."

The cases of delirium tremens which are the most difficult to diagnose and prescribe for, are those which accompany injuries of the skull occurring to persons of intemperate habits, such as brewers' servants, many of whom we have admitted into St. Thomas's Hospital.

The late Mr. Tyrrell, from whose practical skill I derived much valuable knowledge, used to recommend the use of diffusible stimulus, such

* Op. cit.

as ammonia, in the first instance, as a feeler in doubtful cases, as the effect was evanescent, even if it should prove injurious. The pulse is often an uncertain criterion, but it will be generally found that a pulse which alters much, either in rapidity or in power, is not one that indicates inflammatory action. It is generally a sign of weakness. Mr. Tyrrell used to relate a case which occurred in his practice in illustration of this view, and the danger attending an erroneous diagnosis.

Case 2.—A patient was admitted having received a severe blow on the head which rendered him quite insensible. Reaction took place very slowly; Mr. T. first gave him ammonia, and afterwards a small quantity of porter: he improved slightly. In the evening he was seen by another surgeon, who took a different view of the case, and ordered him to be bled from the arm. He died the following morning, with serous effusion on the brain, but no signs whatever of inflammation or congestion.

Anæmic Coma.—We have seen that delirium may arise from an anæmic condition of the brain, and we shall next observe that a state of insensibility may be produced by similar causes.

I believe that if cerebral anæmia be allowed to continue for a long period, it will occasionally terminate in hydrocephalus, and also in the white form of ramollissement.

We will first consider anæmic hydrocephalus, with its effect, anæmic coma, for I believe that there are two forms of hydrocephalus, the one anæmic, the other inflammatory, as well as two forms of ramollissement.

Dr. Marshall Hall was one of the first to point out the resemblance which exists between a comatose condition arising from exhaustion, and that which is occasioned by inflammation and effusion. The affection which Dr. Hall described, arises principally in infants, but it is not confined to them. He calls it "an hydrencephaloid affection of infants arising from exhaustion."

Dr. Hall has observed this affection generally as a consequence of continued diarrhœa, produced either by bad diet or long-continued use of purgative medicines, or as a consequence of blood-letting. He divides the affection into two stages, "the first that of irritability, the second that of torpor; in the former there appears to be a feeble attempt at reaction, in the latter the nervous powers appear to be more prostrate." He thus describes the signs of complaint: "The infant becomes irritable, restless and feverish, the face flushed, the surface hot, and the pulse frequent; there is an undue sensitiveness of the nerves, and the little patient starts on being touched, or from any sudden noise; there are sighing, moaning, during sleep, and screaming; the bowels are flatulent and loose, and the evacuations are mucous and disordered. If, through an erroneous notion as to the nature of this affection, nourishment and cordials be not given; or, if the diarrhœa continue, either spontaneously or from the administration of medicine, the exhaustion which ensues is apt to lead to a very different train of symptoms. The countenance becomes pale, and the cheeks cool or cold; the eyelids are half closed, the eyes are fixed, and unattracted by any object placed before them, the pupils unmoved on the approach of light; the breathing, from being quick, becomes irregular and affected by sighs; the voice becomes husky; and there is sometimes a husky, teazing cough; and

eventually the strength of the little patient has been subdued, and the vascular system exhausted, by abstraction of blood."

Dr. Hall considers that this affection is to be distinguished from true hydrocephalus principally "by observing the condition of the countenance, and by tracing the history and causes of the affection."

Dr. Abercrombie observes,* "In the last stages of diseases of exhaustion, patients frequently fall into a state resembling coma, a considerable time before death, and while the pulse can still be felt distinctly; I have many times seen children lie for a day or two in this kind of stupor, and recover under the use of wine and nourishment. It is often scarcely to be distinguished from the coma which accompanies diseases of the brain. It attacks them after some continuance of exhausting diseases, such as tedious or neglected diarrhœa, and the patients lie in a state of insensibility, the pupils dilated, the eyes open and insensible, the face pale, and the pulse feeble. It may continue for a day or two, and terminate favorably, or it may prove fatal. This affection seems to correspond with the apoplexia ex inanitione of the older writers. It differs from syncope by coming on gradually, and in continuing a considerable time, perhaps a day or two; and it is not, like syncope, induced by sudden and temporary causes, but by causes of gradual exhaustion going on for a considerable time. It differs from mere exhaustion, in the complete abolition of sense and motion, while the pulse can be felt distinctly, and is, in some cases, of considerable strength. I have seen in adults the same affection, though perhaps it is more uncommon than in children." In a letter which Dr. Hall received from Dr. Abercrombie, that gentleman observes, "The state of infants which I have referred to, is a state of pure coma, scarcely distinguishable, at first sight, from the perfect stupor of the very last stage of hydrocephalus, the child lying with the eyes open, or half open, the pupils dilated, the face pale. It is difficult to describe distinctly the appearance, but it is one which conveys the expression of coma, rather than of sinking; and I remember the first time I met with the affection, the circumstance which arrested my attention, and led me to suppose the disease was not hydrocephalus, the state somewhat different from coma, was finding on further inquiry, that it came on after diarrhœa, and not with any symptom indicating an affection of the head. The child recovered under the use of wine and nourishment."

"The remedies for this affection," says Dr. Hall, "are such as will check this diarrhœa, and afterwards regulate the bowels and restore and sustain the strength of the little patient. With the first object, it may be necessary to give the tinctura opii and chalk, and afterwards the pilula hydrargyri, rhubarb and magnesia; with the second, sal volatile, but especially brandy, and proper nourishment are to be given according to circumstances. But in this, as in so many cases of infantile disorders, the young milk of a young and healthy nurse is the best remedy of all; in the absence of which, asses' milk may be tried, but certainly not with the same confident hope of benefit."

"Five or ten drops of the sal volatile may be given every three or

* P. 72, 76.

four hours, and twice or thrice in the interval five or ten drops of brandy may be given in arrow-root done in water. As the diarrhœa and appearances of exhaustion subside, these remedies are to be subtracted, the bowels are to be watched and regulated, and the strength is to be continually sustained by the nurse's or asses' milk. The brandy has sometimes appeared to induce pain—sal volatile is then to be substituted for it; a dose of magnesia has also appeared to do good. For the state of irritability, the warm-bath is a remedy of great efficacy. For the coma, a small blister or sinapism should be applied to the nape of the neck. A state of exhaustion of the general system, as I have observed elsewhere, by no means precludes the possibility of real congestion of the brain. It rather implies it. In extreme cases these are not only the symptoms of cerebral congestion during life, but effusion of serum into the ventricles of the brain is found on examination after death. In every case the extremities are to be kept warm by flannel, and the circulation should be promoted in them by assiduous frictions. It is of the utmost importance carefully to avoid putting the little patient into the erect posture. A free current of air is also a restorative of the greatest efficacy."

Dr. M. Hall follows up this account with some excellent cases very illustrative of his views; he also quotes the following observations of Dr. Gooch, which, like all that this excellent practitioner ever penned, are worthy of attention:—

"*Case* 3.—A little girl, about two years old, small of her age, very delicate, was taken ill with the symptoms which I have above described. She lay dozing, languid, with a cold skin, and a pulse rather weak, but not much quicker than natural. She had no disposition to take nourishment. Her sister having died only a week before of an illness which began exactly in the same way, and some doubts having been entertained by the medical attendant of the propriety of the treatment, leeches were withheld, but the child not being better at the end of two days, the parents, naturally anxious about their only surviving child, consulted another practitioner. The case was immediately decided to be one of cerebral congestion, and three leeches were ordered to be applied to the head.

"As the nurse was going to apply them, and during the absence of the medical attendants, a friend called in who had been educated for physic, and who had great influence with the family; he saw the child, said that the doctors were not sufficiently active, and advised the number of leeches to be doubled. Six, therefore, were applied; they bled copiously: but when the medical attendants assembled in the evening, they found the aspect of the case totally altered, and that for the worse; the child was deadly pale, it had scarcely any pulse, its skin was cold, the pupils were dilated and motionless when light was allowed to fall on them, and when a watch was held to its eyes it seemed not to see; there was no squinting. Did this state of vision depend on the pressure of a fluid effused into the brain since the bleeding, and during this exhausted and feeble state of circulation, or did it depend on the circulation of the brain being too languid to support the sensibility of the retina? It is well known that large losses of blood enfeeble vision. I saw a striking instance of this in a lady who flooded to death. When I entered the chamber she had no pulse, and she was tossing about in that restless state which is so fatal a sign in these terrific cases. She could still speak, asked whether I was come (she knew I had been sent for), and said, 'Am I in any danger? how dark the room is! I can't see.' The shutters were open. the blind up, and the light from the window, facing the bed, fell strong on her face. I had the curiosity to lift the lid and observe the state of the eye; the pupil was completely dilated, and perfectly motionless, though the light fell strong on it. Who can doubt that here the insensibility of the retina depended on the deficiency of its circulation?—But to return to the little patient. The next day she had vomited her food several times; it was, therefore, directed that she should take no other nutriment than a dessertspoonful of asses' milk every hour, and this was strictly obeyed, and continued for several days. The child wasted, her features grew sharp, and every now and then she looked fretful, and uttered a faint squeaking cry; the eyeballs became sunk in the socket, like those of a corpse that had been dead a month; the skin continued cool, and often cold, and the pulse weak, tremulous, and sometimes scarcely to be

felt. Under this regimen, and in this way, she continued to go on for several days. At times she revived a little, so as to induce those who prescribed this treatment to believe confidently that she would recover; and she clearly regained her sight, for if a watch was held up to her she would follow it with her eyes. She lived longer than I expected—a full week, and then died with the symptoms of exhaustion, not with those of oppressed brain. The head was opened by a surgeon accustomed to anatomical examinations, and nothing was found but a little more serum than is usual in the ventricles.

"If the reader has perused the foregoing case attentively, and has reflected on it, he will, of course, draw his own inferences. I can draw no other than these: that the heaviness of head and drowsiness which were attributed to congestion in the brain, really depended on a deficiency of nervous energy; that the bleeding and scanty diet aggravated this state, and insured the death of the child; also that the state of the eye which so speedily followed the loss of blood, and which resembled that occasioned by effusion, did, in reality, depend on a deficiency in the circulation of the brain—a fact of considerable curiosity and importance.

"I will now relate a case similar in the symptoms, but very different in the treatment and result.

"*Case* 4.—I was going out of town one afternoon, last summer, when a gentleman drove up to my door in a coach, and entreated me to go and see his child, which he said had something the matter with its head, and that the medical gentleman of the family was in the house, just going to apply leeches. I went with him immediately; and when I entered the nursery, I found a child ten months old lying on its nurse's lap, exactly in the state which I have already described;—the same unwillingness to hold its head up. the same drowsiness, languor, absence of heat, and all symptoms of fever. The child was not small of its age, and had not been weak, but it had been weaned about two months, since which it had never thriven. The leeches had not been put on. I took the medical gentleman into another room, related to him the foregoing case, and several similar to it, which had been treated in the same way. Then I related to him a similar case, which I had seen in the neighboring square, which had been treated with ammonia in decoction of bark, and good diet, which had recovered; not slowly, so as to make it doubtful whether the treatment was the cause of the recovery, but so speedily, that at the third visit I took my leave. He consented to postpone the leeches, and to pursue the plan which I recommended. We directed the gruel diet to be left off, and no other to be given than asses' milk, of which the child was to take at least a pint and a half, and at most a quart, in the twenty-four hours. Its medicine was 10 minims of the aromatic spirit of ammonia in a small draught every four hours. When we met the next day, the appearance of the child proved that our measures had been right; the nurse was walking about the nursery with it upright in her arms. It looked happy and laughing; the same plan was continued another day; the next day it was so well that I took my leave, merely directing the ammonia to be given at longer intervals, and thus gradually withdrawn; the asses' milk to be continued, which kept the bowels sufficiently open, without aperient medicine.

"So inveterate is the disposition to attribute drowsiness in children to congestion of the brain, and to treat it so, that I have seen an infant, four months old, half dead from the diarrhœa produced by artificial food, and capable of being saved only by cordials, aromatics, and a breast of milk; but because it lay dozing on its nurse's lap, two leeches had been put on the temples, and this by a practitioner of more than average sense and knowledge. I took off the leeches, stopped the bleeding of the bites, and attempted nothing but to restrain the diarrhœa, and get in plenty of nature's nutriment, and as I succeeded in this the drowsiness went off and the child revived. If it could have reasoned and spoken, it would have told this practitioner how wrong he was; any one, who from long defect in the organs of nutrition is reduced so that he has neither flesh on his body, nor blood in his veins, well knows what it is to lay

down his head and doze away half the day without any congestion or inflammation of the brain. This error, although I have specified it only in a particular complaint of children, may be observed in our notions and treatment of other diseases, and at other periods of life. If a woman has a profuse hemorrhage after delivery, she will probably have a distressing headache, with throbbing in the head, noises in the ears, a colorless complexion, and a quick, weak, often thrilling pulse, all which symptoms are greatly increased by any exertion. I have seen this state treated in various ways, by small opiates, gentle aperients, and unstimulating nourishment, with no relief. I have seen blood taken away from the head, and it has afforded relief for a few hours, but then the headache, throbbing, and noises, have returned worse than ever; the truth is, that this is the acute state of what in a minor degree, and in a more chronic form, occurs in chlorosis, by which I mean pale-faced amenorrhœa, whether at puberty or in after-life. It may be called acute chlorosis, and, like that disease, is best cured by steel, given at first in small doses, gradually increased, merely obviating constipation by aloetic aperients."

My esteemed friend and colleague, Dr. Risdon Bennett, in his admirable work on Hydrocephalus, advocates the doctrine, that this disease assumes very distinct forms; and that though it undoubtedly does arise in some instances from inflammation, in others it arises from an opposite condition. He says,* "There can be no difficulty in admitting that the physical alterations of softening and serous effusion may be induced by functional and organic changes, very different from inflammation or any allied morbid action." He considers that in by far the largest class of cases, the disease is essentially the *result of scrofulous action*, and may or may not be attended by the signs of inflammation.

The comatose condition which we see occasionally following a severe attack of erysipelas of the head in a debilitated constitution, comes into this category of anæmic affections of the brain. It is difficult to say whether this condition of the brain is the result of that general depression which is both cause and effect in the erysipelas of London, or whether it can be attributed to a derivation of blood to the surface. We all know that in hyperæmia of the brain we can relieve our patients by determining the blood to the surface. It is therefore possible, that this morbid cutaneous determination of blood has the effect of diminishing the supply to the capillaries of the brain as effectually as our artificial measures. In a practical point of view there is nothing more important to the surgeon than a knowledge of the fact that a rambling, incoherent manner in the day, with a restless delirium at night, is no proof of the existence of inflammatory action in the brain. The following case may be selected from many in illustration of this view of the subject:—

Case 5.—In the month of January, 1846, I removed a small tumor from over the parotid gland in a gentleman aged 25.

He imprudently exposed himself to cold after the operation, notwithstanding my strong injunctions to keep his room, for fear of erysipelas being excited. My fears were realized; and a severe attack was the result. My friend Dr. Munk attended the case with me. The erysipelatous inflammation attacked the wound on the fifth day—but I will give the case in his words:—

* The Causes, Nature, Diagnosis, and Treatment of Acute Hydrocephalus, 1848, p. 147.

"The patient went on satisfactorily for some days; but on Saturday, January 31st, he felt unwell, and erysipelas attacked the wound, which, at that time, however, had nearly healed. The redness and swelling extended somewhat over the cheek, and along the neck, and an incision was made through the swollen parts. Port wine, decoction of bark, and small quantities of infusion of senna, were given at intervals.

"I saw the case in consultation with Mr. Solly, on Tuesday, February 3d. The inflammation had then extended over the whole of one side of the face, and the right eye was completely closed. The affected parts were of a dusky red hue; the pulse 120; the bowels purged; and there was some griping. The patient was manifestly anxious about himself, and wandered slightly at times, although answering every question with perfect accuracy. He was ordered eight ounces of port wine, and seven drachms of decoction of bark; one drachm of the compound tincture of bark, and four grains of the sesqui carbonate of ammonia, every four hours.

"The following day (Wednesday, February 4th), he appeared much the same; the erysipelas, however, extending, now implicated the forehead, though not encroaching upon the hairy scalp.

"On Thursday, February 5th, he was, in every respect, decidedly worse; the left side of the face and ear had now become affected, the disease, however, subsiding in the parts first attacked. The forehead was much swollen, tense, and of a dusky-red; the pulse still 120, but decidedly weaker. He wandered considerably, but still replied to questions with tolerable accuracy, though rambling off again immediately. During the night he had been violently delirious; had got out of bed in spite of his attendants; and was with difficulty restrained. His forehead was punctured by Mr. Solly in several places with the point of a lancet, and a large bread-and-water poultice applied. A few drops of blood only exuded. He was ordered to have two ounces of port wine every two hours, and to continue his mixture as before. This was at mid-day. About midnight we found him slightly improved, quiet, rational, and his pulse, if anything, stronger and less frequent. The wine and bark had been given regularly, and he had taken considerable quantities of jelly and strong beef-tea.

"On the ensuing day (Friday, Feb. 6th), at half past four o'clock P.M., we found him again very decidedly changed, for the worse. The erysipelatous inflammation had not extended, but his tongue had become dry, dark-brown, and fissured; his pulse 130, and much weaker: the whole surface was below the natural temperature, and the extremities were decidedly cold. He laid in a heavy, semi-comatose condition, and was altogether incapable of replying to our inquiries. His breathing was becoming difficult and infrequent. Two ounces of port wine were ordered every hour, and to each dose of the mixture, which was now to be given at intervals of two hours, there was added one drachm of the compound spirit of sulphuric ether. A turpentine enema was also employed, at the suggestion of our patient's friend, Mr. Bristowe, of Camberwell, who, throughout, watched the case with much anxiety, and favored us with his assistance and advice during the most alarming stages of the disease. At six o'clock P.M., our patient was seen by his neighbor, Mr. Henry, of the Commercial-Road. He was then sinking rapidly. The pulse had risen to 150, or upwards, and had become weak and thready: the respirations took place at longer intervals, and were more laborious; his legs were icy cold. Mr. Henry poured a full glass of brandy down the throat, and repeated it at intervals of half an hour or an hour; beef-tea and jelly were also given freely. By these means the symptoms of sinking were for the time arrested. At half past ten o'clock P.M., I found him perfectly rational, his tongue moist, and the dark-brown coating gone; the pulse reduced in frequency, from 150 to 112 or 118, and having, in great measure, recovered its strength and volume; his breathing was now natural and easy, and the body and extremities were warm. The brandy was ordered to be continued every hour.

"Feb. 7th.—Our patient went on well during the early portion of the night, but at four o'clock A.M. symptoms of sinking again appeared; his pulse became rapid and weak; the surface cold, and the respirations labored. Drachm-doses of sulphuric ether were now given with the brandy, and under their joint influence he again rallied. Since this, he has been progressing favorably. His pulse is now (ten o'clock P.M.) under 100; skin warm and moist; tongue clean and moist. He is now perfectly rational, and has slept quietly and comfortably at intervals; the inflammation has not extended, and desquamation has commenced; the bowels have not been relieved since last evening; but he feels an inclination to go to stool. He has up to this time continued, and is still to continue, the brandy, beef-tea, &c., at short intervals.

"8th.—Noon: the swelling of the face has now much diminished, and desquamation is taking place over the whole of the affected parts; pulse below ninety, with more power, but unequal, and with a long intermission from time to time. This intermission, however, is less marked at the heart than in the radial artery; tongue moist; feet comfortably warm; owing to the diminution of the swelling he can now open both eyes; he has passed one

healthy evacuation. About four o'clock this morning symptoms of sinking again returned; he breathed with much effort, and the feet and legs became cold, a state which shortly, however, disappeared under the freer use of stimuli. He was now ordered to take the brandy in smaller quantities, and to have two grains of quinine in decoction of bark every four hours.

"On Monday, Feb. 9th, I found him in every respect improved; he was quite collected and comfortable; had slept well during the night; his pulse had more power, and was under ninety in the minute: the skin was warm and moist. Convalescence was from this period steadily progressive. Suppuration of both eyelids took place, and the pus was evacuated by the lancet. He left town on the 26th of February, and returned about the end of March perfectly well.

"Here is an instance of erysipelas treated by what some would perhaps characterize as an undue and lavish administration of stimulants; but I feel fully convinced (and I believe the conviction is equally strong in the minds of those who watched the case) that nothing short of the quantities given would have been competent to bring about a favorable issue. I am no advocate for large doses of medicines in ordinary cases. On the contrary, I am inclined to believe that the tendency of medical opinion and practice is, at the present time, in favor of larger doses than the absolute requirements of disease render necessary; and I am quite sure that benefit would accrue to the patient, in most cases, by a diminution in this respect. It must, however, be remembered, that cases do every now and then occur of such extreme severity as to render ordinary plans of treatment inefficient. In these we must step out of the beaten track, and administer our remedies to an amount which, in more ordinary cases, would be injurious and culpable. The case above related is one in point. I know of no instance of erysipelas in which so large a quantity of stimulants has been necessary: and I certainly have never met with one in which their effects were so strikingly and unequivocally beneficial.

"On Thursday, Feb. 5th, about mid-day, the freer use of wine was commenced. He took two ounces every two hours, and continued it till half past four P.M. of the following day. In the four-and twenty hours he had thus taken twenty-four ounces of wine, besides jelly, beef tea, and the bark-and-ammonia mixture. At half past four o'clock, when Mr. Solly, Mr. Bristowe, Mr. Henry and I saw him, he was sinking, and now two ounces of wine were given every hour, and a drachm of Hoffman's anodyne every alternate hour. Even this quantity did not suffice, and at six o'clock Mr. Henry, with a promptitude and decision to which our patient, I believe, owes his life, commenced the administration of brandy. A wineglassful was given every hour, and continued in the same quantity, and at similar intervals, till Feb. 8th, at noon. During this period of forty-two hours, he took, at the very lowest computation, upwards of sixty ounces of brandy. Notwithstanding the quantity administered, neither the patient's pulse nor his nervous system was at any time unduly excited. On the contrary, the larger the quantity of brandy given, the stronger but less frequent became the pulse, the stupor was diminished, and the delirious wandering quieted. The tongue likewise became clean and moist. The latter circumstance was strikingly illustrated on Friday, Feb. 6th. At half past four o'clock, the tongue was dry, dark-brown, and fissured; at six o'clock he appeared to be dying, and now commenced the administration of brandy. A wineglassful was given at intervals of less than an hour At ten o'clock the tongue had become moist, and the dark-brown coating was gone."

This case requires little comment; it speaks for itself; and it is not a rare one; many such might be brought forward. Our patient was on the brink of the grave; his brain was so disturbed that his intellect had fled. Brandy in quantities which, in a state of health, would have produced complete intoxication and insensibility, restored his senses, removed his fever, and saved his life. It is indeed an interesting question to us, what is the positive state of brain which accompanies this disorder of the intellect. I believe that it is a state of local anæmia. It is not often that we have the opportunity of examining it in its simple, uncomplicated condition, as it so frequently follows an inflammatory state, though the inflammation may have been one of a low or sub-acute character. With the view of ascertaining the condition of the brain, I have always anxiously sought for every opportunity of examining the brain of patients who have died in this state, and I have generally found it free from all signs of inflammation. Nevertheless, though it is true

that in London, as a general rule, erysipelas is a disease of debility, requiring wine, brandy, &c., we must remember that acute inflammation of the scalp will sometimes travel by continuity of tissue to the membranes of the brain, and then prove rapidly fatal, either by serous effusion or by acute inflammation of the hemispherical ganglion. We should therefore endeavor, in our constitutional treatment, to steer a middle course on the onset, keeping, as sailors say, your weather eye open for a storm from very opposite points of the compass. A scruple of rhubarb and calomel, that is, five grains of calomel to fifteen of rhubarb, followed by a senna draught in the morning, clears the prima via and fits the system for either course, as subsequent events may direct. In wounds of the scalp it may be well to remark that often when the pericranium has been extensively separated from the bone, and the edges of the wound heal quickly, there is always danger of subsequent suppuration, and the surgeon must be on the alert to make a free opening, as matter cannot be put up between the tendon of the occipito frontalis and the bone without the brain sympathizing.

I remember inspecting the body of a very fine young woman who died with erysipelas of the scalp, and in whom there was a large collection of pus under the back part of the pericranium, which the medical man failed to detect during life, but which most assuredly must have been instrumental in producing the fatal result, for there was a corresponding inflammation of the membranes of the brain, though not of an active character or great extent; there was also some serous effusion.

A morbid condition of the brain of an anæmic character is often induced in London by long-continued dyspepsia, with confinement in an impure atmosphere. One of the worst cases of this kind I ever saw was the following:

Case 6.—A watch and clock maker, who lived in the neighborhood of Shoreditch, consulted me in January 1840. He was a cripple, and therefore unable to take much exercise, 38 years of age, unmarried, spare habit, and lax fibre. He stated that he had been suffering for the last eight months with a disorder in his head. He described his symptoms in the following words:—Loss of appetite, confusion, giddiness in the head, violent sickness, sleepless nights, horrid dreams, waking suddenly in a fright, noises in the head and ears, sometimes like the singing of a tea-kettle, sometimes like a wineglass or a large rummer struck close to the ear, sometimes like water thrown on a hot iron, or running from a tap, sometimes like a muffled drum at a distance; occasionally on falling off to sleep, he would be awakened by a feeling as if a sky-rocket were shot through his head; sometimes he would be very deaf.

He suffered occasionally from violent headaches, and black and bright spots dancing before his eyes; and to sum up his mental miseries, he had a constant dread of his memory failing him. His bowels were generally relaxed, and he suffered frequently from pain in his stomach.

After carefully balancing all the above symptoms, formidable by themselves, with the following—a languid, weak, irritable pulse, cold skin, pale, flabby tongue—I came to the conclusion, that all his symptoms arose from anæmia, occasioned by inadequate assimilation of his food. I treated him on this view of his case. All his sufferings were relieved, and he was quite restored to health in about two months, by giving him in the first instance small doses of blue pill at night and a mild aperient in the morning, and afterwards light bitters with rhubarb and soda, and strict attention to diet.

I have frequently been consulted by professional men, and others engaged in business in London, who, suffering from London cachexia, have supposed that they have some disease of the brain. In one instance my patient stated that he had lost his memory, that he frequently

would ring the bell and forget before his servant answered it what he had rung it for; he complained, also, of having a sort of *muzzy* feeling in his head, that he could not read or apply himself to anything; horse exercise was dreadful to him. He was a long while in getting well, but it was ultimately effected, entirely by means of very mild tonics.

Bakers are very liable to these affections, owing, I suppose, to their irregular habits, sudden alternations of temperature, and disturbance of the natural hours of rest, &c. I do not refer to the decidedly intemperate. The following brief abstract illustrates my meaning:—

Case 7.—Charles Chadwick, æt. 23, biscuit baker, pale complexion, weak and irritable pulse, states, he awakes in the middle of the night with a start, and is afterwards seized with giddiness in the head, but that he is very much relieved by getting out of bed and walking about his room; this returns two or three times in the same night. He says that it has lately come on in the day. His general health is not very good; has had gonorrhœa for the last twelve months, which is getting a little better. He is now much depressed in spirits.

This case was treated entirely upon a tonic system, principally with quina; he took it for some time, and though the improvement was not rapid, he ultimately recovered.

When these symptoms have lasted some time, they are subdued with difficulty, and require care. It is very necessary that the practitioner should inform the sufferer of their obstinacy, otherwise he will become impatient and dissatisfied. In the treatment of them, stimulants are prejudicial, and the tonics must be very mild. Steel and quinine seldom answer at first, and afterwards only in small doses. Strict diet, pure air, and exercise without fatigue, are more important than medicine. I make it an almost invariable rule to give an active purgative—calomel, &c., at night, haustus senna in the morning; and I examine the evacuation before prescribing any other medicine. If the liver is at fault, taraxacum, with small doses of sulphate of magnesia, and sulphuric acid, will be found more beneficial generally than mercury. This diseased condition cannot be removed by a *coup de main*, and it is not advisable to say much to your patients regarding its nature, for if you convince them that it arises from debility, they think that they have nothing to do but to eat, drink, and sleep, and thus get strong, and then they will be well. On the other hand, you must relieve their minds of the impression, that it is allied to apoplexy, and depends on fullness of the head or inflammation of the brain, which is generally their feeling, or, otherwise, they will be anxious to be cupped, leeched, &c. If you have sensible persons to deal with, you may explain the real rationale of your treatment; if not, you must keep them in ignorance; but especially guard against dropping one word about weakness, for all prefer eating and drinking to taking physic; and they will think they understand all about it, and, throwing physic to the dogs, feed themselves. Finding this fail, they immediately conclude that you have mistaken the nature of their case, go to somebody else, who perhaps orders a few leeches to the head, which sometimes relieve for a day or two, from the reaction which takes place, and this confirms their opinion, until they again get worse.

The state of the nervous functions in a chlorotic female forms another good illustration of the effect of anæmia on the brain. It is not necessary to detail symptoms which are familiar to all.

How instructive it is to watch the gradual disappearance of the headaches, often most violent, under a judiciously managed course of steel

medicine. After the bowels have been freely opened and the tongue clean, there is nothing equal to the old steel mixture with the compound decoction of aloes and aromatic confection, with a drachm of the spiritus myristici; but the practitioner must not expect the headaches to be removed immediately.

I believe that if cerebral anæmia continues for a long while, it will produce white softening, or one form of ramollissement, sometimes in connection with hydrocephalus, as we have seen, sometimes independent of it. This form of disorganization does not often occur in the middle period of life; it sometimes occurs in the infant and the child, as a sequence to hydrocephalus, and in the old man, from disease of the arteries, or other impediments to the circulation; sometimes in the chlorotic female. But we must distinguish the two kinds of softening; there is some difference of opinion as to their nature and origin; I will therefore give a short detail of the opinions of the best pathologists on its real nature.

The term made use of to distinguish this peculiar disorganization of the brain, implies the appearance which it presents to the observer: it is, in fact, *softening* of *the substance* of the brain, generally isolated in its seat. By this the observer distinguishes it from the firmer portions of the brain which surround it, though, as it sometimes happens that the whole brain is softened and broken down into a pulpy mass, he has more difficulty in deciding whether it is truly a morbid appearance, or simply the effect of decomposition. The portion thus broken down does not necessarily lose its natural color, though frequently it becomes darker; however, it never resembles pus either in color or in its disagreeable odor, so that it ought never to be confounded with suppuration.

The earliest observations on this peculiar lesion of the brain are to be met with in the fifth Letter of Morgagni, De Sedibus, &c.,* "which treats of the apoplexy as arising neither from a sanguineous nor a serous cause."

Case 8.—The patient whose case he relates was in her 59th year, and was seized with an apoplexy, followed by loss of speech and paralysis, with loss of sensation of the right side. She was not insensible, for "she gave of her own accord the sound arm to the physicians to have her pulse felt," and "she had no difficulty in swallowing fluids," but did not live many days after her admission to the hospital.

Of the *post-mortem* appearances I shall merely detail those which illustrate the lesion in question; and these I shall give from Dr. Alexander's translation, in the author's own words:

"But let us now go on to the head, for the sake of which, principally, this dissection was performed. While the skull was sawed through, a quantity of serum came forth; and the upper part of it being taken off, and the brain being dissected in its natural situation, we first observed that the dura mater was thickened. And the vessels that ran through the pia mater were all distended with blood, as if they had been filled by injection. This blood was such as that of the whole body, black, and not very fluid. And under the same membrane, in the convolutions of the brain, was seen a transparent water, of the same kind with that which was found in the lateral ventricles afterwards; yet the choroid plexuses were not at all discolored, although they had vesicles upon them turgid with water, and one of these vesicles was equal even to the bigness of a grape. This was in the left plexus, which being taken off, the thalamus nervi optici appeared not of the same color as the right thalamus, but brown. As I cut the brain into small pieces, I observed that every other part of it was natural and sound; but that the medullary substance, which was on the external side of the left thalamus, spoken of above, was very *soft* and *liquefied*, and was found to be mixed

* Translated by Dr. Alexander, 1769, p. 98, article 6.

with a certain bloody fluid, of a color almost effete; so that nothing but a disagreeable smell was wanting to make us pronounce it absolutely rotten. The space of the brain which this disorder occupied was larger than that which the largest walnut would have taken up; and that color of the bloody fluid was most manifest in the middle thereof. It was more natural to take notice of this difference, because the cerebrum in general, as I said, was of its natural color, and not only more hard than the cerebellum, but even endowed with a wonderful hardness everywhere, especially in the whole right hemisphere, and had only, in that place I have mentioned, a kind of bloody color, and a loose ill-compacted substance.

"I believe that this was an *apostema sui generis*, which is agreeable to the opinion even of Avicenna, that an apoplexy might have its origin 'from an apostem formed by repletion;' the violence of which was increased in the patient in question by the water being extravasated, and by the vessels being distended. But this apostem happened about the very place in which, as I have already said, organical injuries most frequently happen according to my observations."

The accurate account which Morgagni has given of the *post-mortem* appearances in this case can leave no doubt as to the real character of the lesion; and it is extraordinary that it should have escaped observation for so long a period after the celebrated author of the work "On the Causes and Seats of Diseases" wrote; for until Rostan published his "Recherches sur le Ramollissement du Cerveau," the second edition of which appeared in 1823, softening of the substance of the brain seems to have been entirely overlooked by the pathologists of Europe.

In the present day, however, no one ought to have any difficulty in distinguishing, after death, the morbid appearances designated *ramollissement* by the French writers, and *softening* by the English. But whether this lesion is the result of inflammation, or whether it is a disease *sui generis*, has not been so clearly decided. Lallemand believes that ramollissement is invariably the result of an inflammatory process, while Andral does not allow that this matter is yet decided. But we will quote Andral's own words; after pointing out the different appearances, he says:*—"Do these different appearances which may be presented by softening of the brain, refer to lesions of a different nature? Are they but degrees more or less advanced of one and the same disease? It is easy to prove that in a considerable number of cases the substance of the brain is first injected, then softened, then secretes pus. This has been excellently well established by M. Lallemand. The softening is then one of the anatomical characters of inflammation of the brain, as it may be of all other organs. But if, in other cases, we do not find within the softening any trace either of sanguineous injection, or purulent infiltration; if we find there, in a word, no other alteration than softening itself, will it not be an abuse of analogy to conclude that in these cases also, the cause which has deprived the brain of its consistence is inflammation? *A fortiori*, will not one be induced to admit it in those other cases where the softened part has become at the same time the seat of an anæmia? Observe, besides, that among those cases of white softening, there are some which have formed very rapidly, after the manner of acute diseases, and in such cases it cannot be supposed that the softening has commenced by a sanguineous congestion, which would disappear, according as the affection would assume a chronic course. No doubt those who refer the proximate cause of every disease to a defect of the normal stimulation, must necessarily make cerebral

* Op. cit., p. 160.

softening enter into one or other of these states, and not finding in this alteration the characters of an asthenic disease, must regard it as an inflammation."

"In thinking so, they but follow their theories; but for us, who think that in a crowd of morbid states there is no more hypersthenia than asthenia, but mere perversion of the vital actions, we are no more obliged to consider the cerebral softening or any other softening as an inflammation than tuberculous pneumonia. It is a specific alteration of nutrition, which may supervene under the influence of morbid conditions widely differing from each other. To endeavor to determine these different conditions is the task to be performed—a task, difficult, no doubt, but of quite another importance from that on which medical men have occupied themselves in latter times, when they have wished to reduce every cerebral softening to one of the forms or one of the degrees of inflammation of the nervous centres. We are convinced that by proceeding thus, men have entered on a course diametrically opposite to that which should lead to the truth. We, too, might collect groups of facts to demonstrate that softening is capable of being produced by different causes of inflammation. Thus we might find some group from which it would result that commencing obliteration of the arteries which enter the brain, is one of the conditions which concur in the production of a certain number of softenings. We might cite other facts which would show us a remarkable coincidence between the *impoverishment* of the blood, or any other alteration whatever of this liquid, and the softening of a great number of our tissues. Are there really so many causes of softening? The future will decide, and will discover, no doubt, many other causes which, in the present state of our knowledge, we cannot even suspect. All that we affirm is, that it is necessary to seek elsewhere than in inflammation for the cause of all softenings. It does not even seem to us that the presence of an unusual quantity of blood in the midst of a softened tissue is a sufficient proof that irritation is the cause of its softening. May it not be that this superabundant blood has flowed into these softened parts but consecutively? See the case where, after a limb has remained for a long time merely paralyzed, it suddenly became rigid, convulsed and contracted; on opening the body we often find, in such cases, one part of the brain softened, and at the same time reddened with blood: reasoning may then lead us to admit that the sanguineous congestion occurred but as a mere complication of softening, and that it is this which caused the phenomena of excitement to succeed the simple loss of motion. In order to explain a cause which simultaneously softened and reddened a tissue, shall we never see anything beyond the mere fact of an irritation which has acted on this tissue? Is it then in the gums of a scorbutic subject that the cause resides which has brought them at the same time to a state of hyperæmia, and deprived them of their consistence?"

"Here, no doubt, are very many questions raised which wait till facts rigorously observed shall come to solve them. But it is enough, we think, that such questions can be put, and that in the future progress of science their solution is possible, to make one distrust very much the opinion which refers every softening to an inflammation. Because

the brain is softened after a blow on the cranium, is that a reason for saying that every time it shall have lost its consistence it must have been previously irritated?"

"If science refuse to admit inflammation as the sole cause of softening the brain, if it see in this softening several other causes, for the proof of which it waits for new researches, it is quite clear that the term *encephalitis* cannot be used as synonymous with the word *softening*. Neither do we think it correct to call this alteration capillary apoplexy, as M. Cruveilhier has done. In a certain number of cases, to be sure, the softening is accompanied, or, rather, complicated with sanguineous infiltration, or effusions of blood more or less multiplied; but certainly it is not in the presence of this blood that the essence of the disease consists, and there are at least many cases in which we do not find the least trace of it. The softening may then be either a capillary apoplexy or an encephalitis; but it is not necessarily either the one or the other."

Dr. Abercrombie,* in speaking of ramollissement, says, "When I formerly endeavored to contribute something to the pathology of this remarkable affection, I had no hesitation in considering it as one of the results of inflammation of the cerebral substance; since that time it has been investigated with much attention by M. Rostan and other French pathologists, and a different view of the nature of the affection has been strongly contended for by these eminent individuals. They consider it as an affection of the brain entirely *sui generis*, and M. Rostan, in particular, seems to look upon it as a peculiar and primary disease of the brain, though he admits it is sometimes the result of inflammation. From all the facts which are now before us in regard to this interesting affection, I think we are enabled to arrive at the conclusion that it occurs under two modifications which differ essentially from each other. In the cases of M. Rostan the disorganization was observed chiefly in the external parts of the brain: it occurred almost entirely in very old people, many of them seventy, seventy-five, and eighty. It was found in connection with attacks of a paralytic or apoplectic kind, many of them protracted, and was often found combined with extravasation of blood, or surrounding old apoplectic cysts. On the contrary, the affection which I had been anxious to investigate, was found chiefly in the dense central parts of the brain, the fornix, septum lucidum, and corpus callosum, or in the cerebral matter immediately surrounding the ventricles; and occurred in persons of various ages, but chiefly in young people and in children. It took place in connection with attacks of an acute character, chiefly the character of acute hydrocephalus; and it was in many cases distinctly combined with appearances of an inflammatory kind, such as deep redness of the cerebral matter surrounding it, suppuration bordering upon it, and deposition of false membrane in the membranous parts most nearly connected with it. We may even observe, in different parts of the same diseased mass, one part in the state of ramollissement, another forming an abscess, while a third retains the characters of active inflammation, and probably exhibits, as we trace it from one extremity to the other, the inflamed state passing gradually into the state of soften-

* Op. cit., p. 24.

ing. Remarkable examples of this will be given in the sequel, and another of a different nature, in which an opening in the septum lucidum produced by the ramollissement was entirely surrounded by a ring of inflammation. This is the affection which I have endeavored to investigate, and which I consider as one of primary importance in the pathology of acute affections of the brain, and upon the grounds now shortly referred to, I cannot hesitate to consider it as a result of inflammation."

"When we compare the facts now alluded to with the observations of M. Rostan and his friends, I think we may arrive at a principle by which the apparent difference may be reconciled. The principle to which I refer is, that this peculiar softening of the cerebral matter is analogous to gangrene in other parts of the body; and that, like gangrene, it may arise from two different causes, inflammation, and failure of the circulation from disease of the arteries. The former I conceive to be the origin of the affection which I have described, and the latter to be the source of the appearances described by M. Rostan. If this doctrine be admitted, the difficulty is removed; and I do not see any good objection to it."

"Gangrene from inflammation is familiar to every one; and equally familiar, though very different in its origin and concomitant symptoms, is gangrene from disease of the arteries of any particular part of the body. Ossification of the arteries of the brain to a very great extent is a common appearance in elderly people, and seems to be a very frequent source of apoplexy, with extravasation of blood, at advanced periods of life. It appears extremely probable that it may be the source of that particular condition of a part of the brain which terminates in the ramollissement of M. Rostan, and indeed he distinctly points at this explanation of it. On the other hand I am still disposed to contend that the ramollissement of young persons occurring in acute affections, and seated chiefly in the central parts, is one of the terminations of inflammation in that particular structure. I conceive it to be an affection of primary importance in the pathology of acute affections of the brain, and to mark a peculiar seat of the inflammation of very frequent occurrence. It is often combined with suppuration in other parts of the brain, and very often with effusion in the ventricles; but the peculiar interest of it is observed in those cases in which it is only the morbid appearance, and in which it is sometimes of small extent. Of this some remarkable examples will be given in the sequel, in which the perforation of the septum lucidum, by softening of a part of its substance, and similar softening of the fornix, were the only morbid appearances in cases which were fatal, with all the usual symptoms of acute hydrocephalus."

On reconsidering all these different opinions, and more particularly the simple but clear-sighted views of Dr. Abercrombie, we are warranted in concluding that the morbid appearance called *ramollissement* is usually the result of acute inflammatory action, but that in old people it frequently follows a total failure of the circulation, corresponding, both in its consequence and in the cause producing it, to asthenic senile gangrene in other parts, and also that it may be the consequence of local and general anæmia even in young subjects. The question regarding

its inflammatory character is peculiarly interesting to the physiologist, from deductions he may draw from the effects which its first stage produces on the functions of the brain, as distinguished from those exhibited after the disease has pursued its course to the actual destruction of its texture.

Gluge,* Henle,† Valentin,‡ Wagner,§ and Dr. Hughes Bennett, of Edinburgh, have made some most important and interesting observations on ramollissement of the brain. To the papers‖ of this last-mentioned excellent pathologist I am indebted for the following information on this subject. Gluge was the first to point out, not only in softening of the brain, but that, in certain stages of inflammation generally, corpuscles are produced, which he has denominated compound inflammation globules. The blood in the capillary vessels stands still. The blood corpuscles lose their coverings and color, only their nuclei remaining. These become agglomerated by means of a white connecting mass, and form thick opaque round bodies, which consist on an average of from twenty to thirty small granules, which, when examined singly, are perfectly clear and transparent. Henle has shown that these granules are contained in a true cell-wall with a nucleus. Valentin, Vogel, and Dr. H. Bennett concur in this view of their structure.

Dr. H. Bennett¶ thus describes the mode in which these exudation corpuscles are developed:—"The blood-plasma or *liquor sanguinis*, which exudes through the walls of the blood-vessels, after a time, which may be shorter or longer, according to circumstances, coagulates in the form of minute granules. These may be seen coating the vessels, and filling up the spaces between them in masses more or less dense. If a small quantity only be exuded, the granules occur in small patches at irregular intervals. (Plate I. fig. 5.) This appears to arise from a comparatively slight degree of congestion, which, however, may produce very intense symptoms from its diffusion over a large surface, as in cases of fever, delirium tremens, &c. When, on the other hand, the congestion is more intense in certain places, the exudation is more abundant, and the granules accumulate in a dense mass outside the vessels, or in the interstices of the elementary structures of the organ. (Plate I. fig. 4.) This exudation serves as a blastema for the production and nourishment of nucleated cells. These may either be formed directly from the fluid *liquor sanguinis* or subsequent to its coagulation. In the former case these may be seen coating the blood-vessels (see Journal, No. 153, Plate V. fig. 6). In the latter imbedded in the granular solid mass (fig. 7, 8). In parenchymatous tissues, where the whole exudation passes into solid coagulation, it is the growth and development of these corpuscles which cause it to break up, and gradually become more and more soft. Thus we have uniformly seen that when the softening is diffluent, perfect corpuscles are few, and that the granules are numerous

* Anat. Mikroscopische Untersuchungen, pp. 12, 13.
† Müller's Archives, 1839, p. 24.
‡ Vogel uber die Erwachung des Gehirns.
§ Wagner, Handworterbuch der Physiologie.
‖ Ed. Med. & Surg. Journal, vol. lviii. pp. 58 and 60.
¶ Ibid., vol. lix. p. 344.

and loose. When it is pultaceous, only the corpuscles are numerous, and the granules less so; and when the diseased part retains to a considerable degree its resistance, or is unchanged, the corpuscles are few, whilst the granules, instead of floating loose, are attached to and coat the blood-vessels. During the progress of disintegration, it frequently happens that portions of the solid exudation are broken up into masses of greater or less size, which are frequently seen of irregular shapes, both attached to the vascular walls, and floating loose in the field of the microscope."

"The exudation corpuscle is formed like all other primary cells—a nucleus is produced, from which a cell-wall arises. During, or subsequent to its full growth, granules are formed between the nucleus and cell-wall. These become more and more numerous, until at length the nucleus is obscured, and the whole cell appears full of, and distended with granules. It presents different appearances at different periods of its growth. At an early period it is very delicate and transparent; the nucleus is very distinct, like a white spot, and the granules exceedingly minute, and few in number. As the development proceeds, the granules become larger and more numerous, the corpuscle assumes a brownish color and becomes more or less opaque. Sometimes it entirely obstructs the rays of light, and looks black. In the observation where the softening resembled chalky milk, the whole cell was full of granules of a large size, each of which was perfectly round and transparent."

"When the exudation corpuscle is distended with granules, it appears to have reached its furthest stage of development: the cell-wall now bursts, and its contents escape. This occurring in numerous corpuscles, causes the coagulated exudation to become soft, pultaceous, or even diffluent. When, by the process of organization thus described, the exuded mass is broken down, it appears probable that the minute granules or molecules, of which it now principally consists, may be re-absorbed, the structures of the organ set free from the pressure the exudation produced, and thus the part return to a healthy state. Gruly tells us, that he has seen the molecules thus produced by the breaking down of pus cells, permeate the coats of the intermediary and capillary vessels, and mix with the blood. This is the process by which it seems probable that hepatization of the lungs is removed. It is impossible, however, to know with certainty whether a similar process takes place in the brain, because the symptoms of exudation into that organ are by no means so unequivocal, but it is highly probable. More generally, however, absorption either does not take place, or is not in proportion to the amount of exudation poured out, and the ultimate structure of the organ is also at length broken up and disorganized. Thus, when inflammatory softening of the brain is diffluent, not only is the exudation mass reduced to granules, but the cylindrical and varicose nervous tubes are broken up into fragments more or less long."

"Dr. Henderson, in an interesting paper on pneumonia, was the first to point out a distinction between the different granular bodies resulting from exudation, as he has observed them in inflamed lungs. He says, 'They do not always present in their agglomerated form the

figure described by Gluge, but are variously shaped, according to the state of perfection in which they may happen to be; while some are globular and exhibit a circular outline, others appear deeply indented and defective, as if a portion of their substance had been removed; and others have nothing of their original round figure remaining.' I think it will appear that these differences do not arise from the stages of development of the exudation corpuscle, as Dr. Henderson supposes, but are caused by the coagulated blood-plasma breaking up into different-sized masses. I have frequently, by means of friction, caused such portions of coagulated exudation to separate, to peel off, as it were, from the exterior of the vessels, and float loose amongst the granules and corpuscles. These bodies I have distinguished by the term exudation *masses.*"

Dr. Hughes Bennett has shown that the most important changes may take place in the cerebral substance, inappreciable to the naked eye, but clearly discernible with the microscope. He also distinguished more decidedly than had been done previously, the inflammatory and non-inflammatory softening.

The following case illustrates very strikingly the value of the microscope in the examination of the brain. It quite confirms the opinion I have always expressed, that every decided deviation from the normal action of the brain would be always found to correspond to some alteration of structure, and that it was only owing to the imperfect manner in which we have hitherto examined the brain that we failed to detect these alterations.

Case 9.—Acute hydrocephalus; death ten days after the commencement of the disease; nothing abnormal in the brain. Vessels of the convolutions abundantly coated with exudation granules.—John Smith, aged 3 years, admitted into the Royal Infirmary, under Dr. Traill, February 12th, 1842.

According to the mother's account, he awoke during the night of the 3d instant with a loud scream, and, by pointing to his head, seemed to indicate that he felt pain there. On the following day he vomited repeatedly, and he has since refused all food. On admission there was constant rolling of the head; pupils contracted on the approach of light; pulse quick and sharp; bowels regular. Two leeches to the head; powders of calomel and sugar

Feb. 13th. Vomited powder; passed a restless night; some tremor observed in the limbs. Blister to the head; clyster; became restless, and died during the night.

Sectio.—Feb. 15. The membranes covering the brain displayed no unusual vascularity. The ventricles contained no fluid, nor was the consisteuce of the cerebral substance in any way altered.

Microscopic examination.—The vessels of the convolutions were in many places slightly coated with exudation granules. The fornix and central medullary parts of the brain presented a similar appearance. The coating of granules here, however, was frequently two and even three times thicker than the vessel to which it was attached, and contained here and there clear, round white spots, similar to the nuclei of the exudation corpuscles.

Remarks.—This case presented the usual symptoms of acute hydrocephalus in children, yet after death no morbid lesion of any consequence was to be discovered. This is a circumstance of by no means unusual occurrence. A more minute examination, however, determined that the capillaries of the central substance of the brain were coated with exudation granules to a very great extent, and that these granules contained among them numerous bodies similar to the corpuscular nuclei. That the exudation in this case should have presented this condition, notwithstanding the violent symptoms, is very curious, and in a histological point of view, exceedingly interesting. It furnishes us with an intermediate stage in the development of the exudation corpuscle, as seen in many of the preceding cases, on the one hand, and those which are to follow on the other.

Dr. Bennett thus sums up his conclusions regarding the two kinds of softening:*—

* Vol. lx. p. 398.

1. That two kinds of cerebral and spinal softening exist, an inflammatory and a non-inflammatory, which may always be distinguished from each other by means of the microscope.

2. That inflammatory softening is characterized by the presence of exudation corpuscles and granules, whilst in non-inflammatory softening these bodies are never found.

3. That the nature of inflammatory softening consists in the formation and development of nucleated cells in exuded blood-plasma: whilst the nature of non-inflammatory softening consists in the mechanical destruction or maceration of the nervous tissue in serum, or is the result of putrefaction.

4. That non-inflammatory softening, unaccompanied by hemorrhage, is usually *post-mortem*, and causes no symptoms; whilst uncomplicated inflammatory softening always causes marked symptoms, which, however, vary according to the seat of the lesion.

5. That the inflammatory and non-inflammatory softenings have frequently been confounded together by morbid anatomists, it being impossible to distinguish one from the other with any certainty by the naked eye.

6. That inflammation in the nervous centres has, in several instances, been demonstrated by means of the microscope, after it has escaped the search of good morbid anatomists, and been indicated by most unequivocal symptoms.

7. That every different colored softening has, at various times, been found to be connected with inflammation, but that yellow and white softenings are most frequently non-inflammatory, whilst the fawn-colored softening is non-inflammatory.

8. That red softenings usually depend on congestion, or the direct extravasation of blood; yellow softenings on the imbibition of the coloring-matter of the blood; fawn and gray-colored softenings on the presence of gray exudation corpuscles; and white softenings, in the great majority of cases, are *post-mortem*, and the result of maceration in serum.

9. In no single instance has softening of the nervous centres been traced to the presence or infiltration of pus.

10. That inflammation of the central parts of the brain generally produce well-marked lesions of sensation and motion; whilst in inflammation of the peripheral portions, lesions of intelligence are commonly well pronounced.

11. That in idiopathic inflammatory softening of the brain, contraction in one or more limbs is a common symptom.

12. That the fawn-colored spots, described by Dr. Sims, are no evidence of the cure of inflammatory softening.

13. That inflammation accompanying hæmorrhages is usually consecutive.

14. The softening surrounding apoplectic clots, or sanguineous infiltration, is no proof of inflammatory action.

The following highly important communication on this subject, I have received from my esteemed colleague, Dr. Peacock. Knowing his accuracy, I have no hesitation in publishing it in full.

"From the opportunity which I had in Edinburgh of observing Dr. Bennett's researches into the microscopic structure of softened portions of the brain, and from a considerable number of cases of cerebral disease which I have since dissected and minutely examined, the following points may, I think, be regarded as established:—

"1st. That in all cases where characteristic symptoms of softening of the brain are present during life, evidences will be found, on microscopic examination, of the extravasation of lymph into the cerebral substance under one or other of the several forms of the so-called exudation granules, corpuscles, or masses:

"2dly. That the appearance of portions of the brain softened after death, either artificially, by manipulation, or from *post-mortem* change, often, to the naked eye, so closely resembles the genuine results of disease as to render it extremely difficult, if not impossible, for practised morbid anatomists to decide between them:

"3dly. And consequently that portions of brain, presenting every appearance of softening to the naked eye, but in which the microscope does not reveal the presence of some form of exudation, intermixed with the broken-up cerebral substance, cannot, in the present state of our knowledge, be regarded as having resulted from any diseased process during life.

"In support of these propositions, I have selected the two following cases from a number of unpublished observations of my own; they will be observed to confirm several of Dr. Bennett's conclusions, and show, 1st, that softening of the brain may prove fatal at a period when the local changes are so little apparent, as to be scarcely detectable to the unaided sight, yet that, in this stage, their nature may be rendered conclusive on microscopic examination; 2dly, that in the same brain there may exist softenings essentially resulting from morbid processes during life, and others dependent simply on changes after death; and that the respective nature of these, not certainly capable of solution by ordinary vision, become apparent when recourse is had to the use of the lens.

"*Case I.*—Vourdelot, a female, 69 years of age, was admitted into the Salle St. Madeline, at La Charité, under the care of M. Bouillaud, on the 23d of February, 1844.

"She stated that she had been seized on awaking the morning before with entire loss of motion and general numbness in the left arm and leg, in consequence of which she was incapable of leaving the bed. The morning of her admission she had some pain in the head, and felt giddy when sitting up; she had not had any feeling of sickness or vomiting. When admitted she looked sallow and feeble, but had no particular expression of suffering. The angle of the mouth was slightly drawn to the right side. The tongue did not present any material deviation, and was freely movable; it was moist and somewhat red. The pupils were of natural size, and sensible to light; the hearing was entire. She had some difficulty of speaking and swallowing. The leg and arm were entirely paralyzed; and the forearm was flexed upon the arm, and rigid. She had experienced some difficulty of making water, but the bowels had been naturally relieved. The pulse was 88, and sufficiently strong. There was no increased dullness in the region of the heart, and the sounds, though flat, were far from morbid murmur. The respiration was natural. She referred the pain in the head to the upper and middle part of the right side; she had no giddiness except when sitting up; the intelligence was scarcely impaired. She was directed to be bled to 3 palettes.

"On the 24th, the paralysis continued much as before, and was combined with semiflexion of the joints, which ceased on extension. The mouth was slightly drawn to the right side. The lips had their natural movement when she attempted to blow; the motions of the eyelids were natural. The pulse was 88, and firm; the heat of skin moderate. The blood drawn the night before was moderately contracted, and without any buffy coat. M. Bouillaud gave as his diagnosis—Cerebral hemorrhage in the optic lobes, or corpus striatum, of the right side, or in their immediate neighborhood, with softening of the cerebral substance around, probably ossification of the central arteries. The symptoms underwent little change after this date. The power of speech, which had never been greatly affected, was much improved after the bleeding, and the intelligence continued perfect. The contraction and rigidity of the left arm were very irregular; though decided on the evening of her admission, it was nearly absent at the time of M. Bouillaud's visit the following morning; and again in the evening it existed, though not to a great degree. The left leg was throughout in a state of complete resolution, and the sensibility was unaffected in both limbs.

"On the 25th, the bowels not having been relieved, she was directed to take one grain of the potassio-tartrate of antimony in a basin of broth; portions being drank at intervals. This did not produce vomiting, but acted moderately on the bowels. Towards the evening she became delirious and restless, then sank into a state of coma, and died at 5 A.M. on the 26th.

"The body was examined at 9 A.M. on the 27th. The heart was of large size, the walls of the left ventricle being unusually thick, and its cavity small. The aorta and bicuspid valves were somewhat thickened and opaque. The lungs and organs in the abdomen were healthy.

"In the brain there existed considerable sub-arachnoid effusion, and fluid was found in large quantities at the base; and the basilar and central arteries, and their divisions, were extensively ossified. The cerebral substance was of natural firmness; the sections were abundantly sprinkled with red dots. Divided into small sections, and examined with the greatest care, the brain displayed no trace of hæmorrhage or softening, unless, perhaps, the optic thalamus and corpus striatum of the right side were slightly less firm than the same parts of the opposite side. There was observed nothing unnatural in the ventricles, pons Varolii, medulla oblongata, or spinal marrow; all these parts retained their natural firmness, and the only striking peculiarity was the altered condition of the coats of the various cerebral arteries.

"In this report I have purposely retained the words dictated by M. Bouillaud to his extern in the Post-mortem Theatre, to show that every care was taken to ascertain the state of the brain and spinal cord; and that, with the attention specially directed to the central portions of the right hemisphere, they afforded no satisfactory, or even probable, evidences of softening. Having taken portions of the thalamus and corpus striatum, I subjected them to a careful microscopic examination, and obtained very characteristic proofs that morbid changes had been proceeding in these parts sufficient to account for the symptoms present during life. The scarcely softened portions of the right thalamus and corpus striatum, though scarcely more tinged with blood than natural, as viewed by the naked eye, were found, on microscopic examination, to contain numerous blood globules, and the tubes were much broken up; along the sides of the capillary vessels the small exudation granules were found extensively extravasated, and occasionally there existed in the adjacent cerebral tissue the large round clusters of granules, to which the terms exudation corpuscles and masses, have been applied. The exudation was, however, chiefly in the granular form, and confined to the sides of the vessels, and thus corresponded with the very slight amount of softening produced. The granules were found in portions of the corpus striatum and thalamus opticus, which were far from any appearance of softening.

"The report of the microscopic appearances in this case, and which so fully confirmed the correctness of the diagnosis formed during life, I had the pleasure of communicating to M. Bouillaud, through his Chef de Clinique, M. Lemaire.

"The second case occurred in my own practice more recently; it is as follows:—

"*Case* II.—John Fletcher, æt. 62, a porter, admitted into the Royal Free Hospital, August the 15th, 1846. He stated that he had lived very freely for the last 14 years, but enjoyed good health till about a month before his admission. He then began to suffer from breathlessness, cough, and swelling of the extremities, more particularly of the legs, and latterly of the abdomen. When admitted, he complained of difficulty of breathing, but had no pain in the chest; he had a severe cough, and expectorated some frothy mucus. The body was generally anasarcous, and the abdomen tumid, and fluctuated on percussion. The tongue was covered with a brown fur; the pulse was 88, and tolerably resistent; the respirations 28, short and labored. The urine acid, very albuminous, and of a deep brownish red color; in quantity it amounted to three pints during the twenty-four hours. The chest sounded generally dull on percussion, both before and behind; but it was relatively less resonant in the right side, towards the lower part. The respiration was throughout feeble, and attended by a prolongation of the expiratory sound. It was weaker on the right side, and absent at its lower part. The respiration was generally attended with sonorous and sibilant rales, and a moist, and somewhat small, crepitation was heard over the lower part of the back, at each side. The extent of the cardiac dullness was not materially increased. The action of the heart was regular, the sounds nearly inaudible, from the loud pulmonary sounds; but, on the breath being held, a rough and grating murmur was heard, with the impulse of the heart, over the whole præcordia. This murmur was loudest at a point one inch below the nipple, but it was also distinct between that body and the sternum, and was audible over the upper third of the sternum. The second sound was heard both at the base and apex, and was grating and rough in its character, but was unattended by murmur. On the 22d he complained of much pain in the region of the heart, and there was increased difficulty of breathing; deep brown-colored expectoration, occasionally bloody; great lividity of face, and very scanty secretion of urine: during the whole period he was in the hospital he had been in a state of great mental torpor, with muttering delirium, though rational when aroused; the tendency to coma now increased, he breathed stertorously, became entirely insensible, and died on the morning of the 26th of August.

"The body was examined at 4 P.M. the same day.

"The right side of the chest and the cavity of the abdomen contained much deep amber-colored serum. Both lungs were very sparingly crepitant, and exuded much serum on compression, especially the right, which was much compressed. The bronchi were dilated; the tubes filled with glairy mucus, and the mucous membrane reddened. The heart was very large, weighing one pound (avoirdupois); it was much overlapped by the left lung. The

serous coverings were coated by a thin and very soft layer of lymph. The right ventricle was hypertrophied and much dilated. The left ventricle very large, and its walls greatly increased in thickness. The aorta orifice was small, and the valves much ossified at their attachments, and a mass of atheroma projected between the angles of the right and posterior crescents. The valves, though probably competent, had evidently formed an obstruction to the passage of the blood from the ventricle. The mitral valve was also thickened, and its aperture somewhat contracted. It had a hard atheromatous mass projecting from the right extremity of its folds. The auricles, especially the right, were large. The aorta displayed much atheromatous thickening, and the orifices of the coronary arteries were surrounded by deposit, but not materially strictured. The chylopoietic organs were congested; the kidneys were somewhat granular; the proper coat adherent.

"The brain weighed 39¾ oz. (avoirdupois).

"There existed much fluid in the sub-arachnoidal cellular membrane, in the cavity of the ventricles, and at the base. The convolutions on the superior surface of the hemispheres were very narrow, convex, and widely separated from each other; the pia mater was very readily removed from them. This atrophy of the convolutions was most marked at the upper surface of the anterior lobes, and here there existed patches of softening of the surface, as also at the under surface of the anterior and middle lobes. The softened portions were of a deep amber color, and occupied chiefly the convexities of the convolutions. The softening seemed to have commenced on the free surface of the gray matter, so that, on removing the pia mater, a portion of the altered tissue adhered to it, and a furrow was exposed, filled by a diffluent pulp. In some places the surfaces of the convolutions were only slightly abraded: in others the softening involved the whole thickness of the cortical substance; but in none did the change appear to implicate the subjacent medullary matter. The gray matter of the brain for some distance around the patches of softening was of a hard and almost horny consistence, had a peculiar semi-transparent appearance, and was of a leaden hue. The softened matter, when more minutely examined, was found to consist of a diffluent or fluid portion, readily miscible with water, and a more solid material of a deep amber color, of the consistence of firm gelatine, and only admitting of being broken down with difficulty. The former, examined by the microscope, consisted of broken down cerebral substance, with capillary vessels having exudation granules on their sides, and a few exudation corpuscles mixed with the cerebral substance. The latter was composed of little else than dense masses of aggregated granules of exudation. Both materials were intermixed with free oil globules, and contained tabular crystals, apparently of cholesterine.

"On the free surfaces of the corpora striata, in each ventricle, there existed patches of softening. The cerebral substance was in these almost diffluent, but retained its natural hue, and, when subjected to the microscope, was found to present no other peculiarity than being mixed with an unusual proportion of fluid, and the tubes broken up and separated. There was no evidence of exudation.

"The various cerebral arteries were covered with atheromatous matter, but to a less extent than is frequently seen in elderly persons.

"In this instance the brain presented two very different forms of softening—the one, involving very extensively the gray matter of the convolutions, was evidently inflammatory in its origin; the other, affecting the surfaces of the corpora striata, was most probably the result of *post-mortem* changes. These inferences accord, it will be observed, with the symptoms present during life. The previous history of the patient was not ascertained: he was brought into the hospital in a state of destitution, and presented at that time, as well as afterwards, great mental hebetude, with partial delirium, gradually lapsing into complete coma; the disturbance of the intellectual functions which chronic disease of the gray matter of the brain would be expected to induce. On the other hand, he had, throughout his illness, no convulsive attack or paralysis; which would have existed had the central softening resulted in a morbid process; and which, we have seen, was present in the first case, though the change in the corpus striatum was, to the naked eye, much less obvious.

"The inflammatory softening of the gray matter of the brain was, in this case, probably of considerable duration. The deep amber color of the softened portions, the darkness and induration of the surrounding cineritious matter, and the dense, opaque. and irregular masses of exudation, found on microscopic examination, correspond with what I have observed in several other cases of chronic softening of the surface of the brain, and exist to a less degree in cases of chronic softening of the medullary substance. The dark color of the softened portions and the density and large size of the exudation masses, are, I believe, characteristic of the slower forms of cerebral softening.

"The changes undergone by the surfaces of the corpora striata in this case are also characteristic of the most frequent form of what is believed to be *post-mortem* softening; and the case affords an example of the circumstances under which this change most frequently occurs. The softening appears to be dependent on infiltration of the serum, effused into the ventricles

and the adjacent cerebral substance; and the appearances presented on microscopic examination are such as would thus result. I have many times observed this state, and have noticed its various stages, from a degree of infiltration producing only a sudden appearance of portions of the boundaries of the ventricles, to the complete destruction of extensive portions of the corpora striata, thalamus, fornix and septum, forming a thick milky pulp, floating in the ventricular cavity. This extensive softening I have seen unattended by any symptoms of paralysis or contraction during life, as, were it produced before death, could certainly not be the case. It is generally, however, if not always, found in cases of very copious effusion from acute inflammation, and is especially common after the arachnitis of children. The production of the softening is, therefore, probably aided by a slight extension of disease from the inflamed serous membrane to the parts beneath, analogous to the slight change, which, in cases of pleurisy or pericarditis, affects the portions of the substance of the lungs and heart contiguous to the serous membrane.

"In cases of extensive chronic effusion into the ventricular cavities, the parts around are most frequently indurated, as we find in the cases of serous effusion after chronic insanity, after death from diseases attended with great emaciation, and in persons who die at an advanced period of life.

"There is another remark which suggests itself in reference to these cases: both were, it will be observed, elderly persons, the one originally of feeble constitution, and debilitated; the other exhausted by organic disease in two other organs: in both, the arteries of the brain were diseased, and in the last the softening involved extremely different portions of the surface of the brain. They were, therefore, both persons in whom the form of softening, regarded by Rostan and Recamin as non-inflammatory, might have been expected to be found; yet, in each case, microscopic examination of the diseased portions afforded conclusive evidences of the presence of inflammation. The inference which thus suggests itself is supported by several other cases I have had the opportunity of observing, and I cannot but regard the views of these pathologists as doubtful.

"The importance of the color of softened portions of the brain, as affording the means of distinguishing the nature of the change, has, I believe, been overrated; and while it is probable, that all cases of softening of some duration will be found to present decided changes of color, referable either to the engorgement of the part with blood, to slight sanguineous extravasation, or to the color of the exuded material, we have evidenced, in the first case, that inflammatory softening may prove fatal without the tissue having undergone any alteration of color. The difference between the processes of cerebral softening in persons at early and advanced periods of life I regard as perfectly analogous to those which, under similar circumstances, affect other forms of diseased action."

Atrophy of the Brain.—There is no doubt that the brain, either as a whole or in part, becomes atrophied, though more frequently the latter. It may arise from arrest of development in the fœtal state. The anencephalous fœtus is the most complete illustration of this form of atrophy. Sometimes the arrest of development is confined to the hemispherical ganglion, and then the brain retains the same condition permanently, which, in a normal state, would be merely one of its stages of growth. There is an excellent account of this disorder, with illustrations, in Cruveilhier's Morbid Anatomy.

Cruveilhier describes another form of atrophy as resulting from the pressure of serous effusion into the ventricles in childhood; but this I consider does not deserve to be considered as a true case of atrophy; it is in reality simply a case of chronic hydrocephalus in childhood, which, causing a dilatation of the left lateral ventricle at the expense of the tubular portion of the hemispheres, has been partially absorbed, and hence the paralysis. The hemispherical ganglion or cortical substance was neither atrophied nor absorbed, but in normal quantity, as demonstrated by the section, and the rugæ on the surface were much more numerous on that side, and hence the preservation of the intellect.

A third form is that which follows chronic inflammation of the hemispherical ganglion; we often meet with it in the brain of old standing cases of insanity, where the patient has sunk into a complete state of

fatuity. The convolutions are then narrow and pinched, almost sharp, instead of being flat and rounded, full and plump. In some cases the ganglion is actually thinner, as may be seen on section. A fourth is simple senile atrophy. In very old age the brain, like other organs, is less perfectly nourished, and like other organs, shrinks in bulk. The wide fossæ between the two convolutions are filled with that beautiful protector, the cerebro-spinal fluid: for in these cases the excess of this fluid is not to be regarded as morbid; it is the cushion which nature has kindly provided to supply the deficiency of brain. Still it must, I think, be allowed that the brain of old people is more exposed to injury from external violence than the adult. This I conceive arises from its being more easily shaken in its case. It is only upon such a supposition that we can account for those instances of laceration of the brain from a blow on the skull unaccompanied with fracture, an accident which is comparatively rare in the younger subject. The following case I have selected from among others as a good illustration of the accident:—

Case 10.—Elizabeth Swannell, æt. 69, a cook, was admitted, under the care of Mr. Green, into Elizabeth's ward, St. Thomas's Hospital, on the 24th of February, 1841, at half-past four, P.M., having received a large contused wound which exposed the bone over the right eyebrow. No fracture or further external injury could be detected. Symptoms on admission:—Perfectly insensible and motionless; left pupil very much contracted and fixed, the swelling of the surrounding part preventing the state of the right from being ascertained; breathing labored, with a stertorous noise; pulse 96, full, and not easily compressed; extremities moderately warm; fæces and urine involuntarily passed; great rigidity of the muscles, especially of the right arm and left leg; frothy saliva issuing from the mouth; no spirituous odor could be detected in the breath.

History.—Shortly after two o'clock, while going down stairs, she suddenly fell, and was picked up exactly in the same state in which she was brought to the hospital. Was not subject to fits. Nobody saw the accident.

Treatment.—A surgeon had bled her in the left arm previous to admission. Soon after she was brought in, she was cupped to ℥ix from the nape of the neck, a large blister was applied to the back part of the head, which was shaved, and hot water applied to her feet. Breathing slightly relieved by cupping; pulse continues full, and at 92. At nine o'clock, I saw her, with Mr. B. Travers, apparently exactly in the same state, except that her pulse varied in frequency from 76 to 92; it was very full, but did not indicate sufficient strength to bear further loss of blood; the breathing was not quite so labored. At 11 o'clock I gave her grs. viij. of calomel.

Feb. 25th, 9 A.M.—No improvement in respect of sensation or motion: pupil contracted and fixed: pulse 90, and full, breathing a little impeded by mucus, much frothy saliva issuing from the mouth. She remained exactly in the same state, her pulse continuing full, and about 90, till within two or three minutes of her death, which took place at 10 minutes past 4 P.M.

Post-mortem.—The brain did not seem to fill the skull completely. No morbid appearance on the surface of the brain. Tentorium smeared with blood. Interior.—Extensive effusion of blood into the left ventricle; some into the right: this effusion appears to have resulted from laceration of the left corpus striatum and thalamus, also those fibres of the great commissure which form the anterior part of the roof of the left ventricle. The lacerated corpus striatum and thalamus were forced into the right ventricle under the fornix, and, when first observed, looked almost like a medullary tumor with an ulcerated surface.

In this case the brain appears to have been lacerated by the "contre coup," to which it was especially exposed from its diminished size, in relation to its containing cavity, the result of senile atrophy.

Hyperæmic Affections of the Brain.—From the *anæmic* affections let us now direct our attention to the hyperæmic. First, the inflammatory.

These may be divided, for the sake of convenience, into the following heads:—

Inflammation of the Brain from without:

1. Inflammation of the brain from concussion. 2. Inflammation of

the brain consequent upon and continuous with inflammation of its protective apparatus, viz., the pericranium, the cranium, and the cerebral membranes, whether caused by injuries, local diseases, or constitutional diseases.

Inflammation of the brain consequent on metastasis, such as the retrocession of an eruption, &c.

Inflammation of the Brain from within:

Inflammation of the brain from over action, mental emotions, sudden fright, &c.

Inflammation of the brain is a wide subject, for the brain, unlike the liver, lungs, kidneys, &c., is not, as we have seen, a single instrument performing one office. It is made up of many instruments, each having its individual function to perform. The symptoms of the disease will therefore vary according to the portion which is diseased. It is true, that all the ganglia within the skull are so closely united that any single ganglion can scarcely be affected without the rest sympathizing. Still inflammation is sometimes restricted and the symptoms peculiar.

I believe, 1st. That inflammation of the hemispherical ganglion may be distinguished from inflammation of the rest of the encephalon. 2dly. That inflammation of the upper portion of this ganglion may be distinguished from that inflammation which is at the base of the brain. 3dly. That inflammation of the medullary or tubular substance, though seldom occurring alone, may be distinguished from that of the ganglia. 4thly. That inflammation of the cerebellum has its characteristics.

The most important portion of the brain, as regards our relation to the external world, is the hemispherical ganglion or cortical substance. From its exposed position this ganglion is that portion of the brain which is most frequently disordered and diseased. It will be well to consider, *first*, what morbid changes it is liable to, their consequences and terminations, and *afterwards* review the various circumstances which may give rise to them, such as disease and injuries of the skull and membranes, &c. &c. Inflammation of the hemispherical ganglion is usually described by authors as inflammation of the membranes of the brain—*meningitis*—overlooking entirely the more important organ affected. This will be adverted to again.

I am afraid that in many cases the *post-mortem* appearances of meningitis are not always detected. There is no doubt that it is often difficult in many cases to decide after death whether there has been any undue vascularity of the pia mater during life. The position in which the head has been placed after death in relation to the body, should always be attended to, for if the examination is shortly after death, the blood still fluid, and the head hanging down, the cerebral vessels are sure to be full. On the other hand, if the head has been raised, and the chest opened before the head, and the great vessels of the heart divided, so that a large quantity of the blood escapes, the meningeal vessels which, during life, had been over-filled with blood, may be unloaded and empty. Still it will be found that these accidental circumstances affect the larger vessels rather than the capillaries. The morbid appearances of the arachnoid which indicate the existence of inflammation, cannot be so easily affected. These are—First, Opacity. It is true that this is a very com-

mon appearance, but still it is one which I believe all pathologists agree in considering the result of chronic inflammation. Secondly. Dryness of the arachnoid. This is by no means common, but I quite agree with Dr. Bright in saying, "In many cases of high cerebral irritation, and where we have reason to suspect actual inflammation, this appearance occurs; and there is no reason to doubt that in this membrane, as in others, a defective secretion is amongst the well-marked signs of inflammation." Thirdly. Effusion of lymph and fibrine are proofs of inflammatory action.

The effect of inflammation on the hemispherical ganglion, in producing morbid alterations of structure, depends much on the intensity of the inflammation, and its duration.

The appearance which it presents after death, will vary according to the time at which death occurs in relation to the occurrence of the attack. These alterations may be divided into alterations in consistency and alterations in color.

Thus there are softening and hardening. In regard to color, the changes are very striking. In health, the color varies a little, but the variation is slight. The natural color may be closely imitated in water colors, by mixing light red and Indian red; it is difficult to describe it in words. Dr. Bright has called it "a light fawn-colored brown."

In disease the color varies from a pale tint, scarcely darker than the medullary substance, up to an intense purple; occasionally it assumes a bright scarlet; but we seldom have the opportunity of seeing it in this state, for it is the result of active inflammation, and patients seldom die during this stage of the disease.

For some time, I took every opportunity of making a colored drawing of the cortical substance, or hemispherical ganglion, of all patients indiscriminately that I could examine after death; at this time I went a great deal to Hanwell, and, through the kindness of that noble benefactor of his fellow creatures, Dr. Conolly, I had many opportunities of examining the brains of the insane.

The general result of my observations was, that a pale condition of this ganglion was almost invariably found in patients who had sunk into a state of mental imbecility, and was generally associated with some serous effusion and thickening of the arachnoid and pia mater.

In patients who had been long inmates of the asylum, and in whom the disease had ebbed and flowed, sometimes producing high excitement, and sometimes depression, I often found a mottled appearance.

The following abstract, from the details of a case noted at the time, will explain what I mean:—

Case 11.—Mania, Hanwell, April 23d, 1842. Thomas Griffiths was admitted on the 16th March, 1842; he was violent and refractory, but not showing any disposition to injure any one; very sleepless, opiates having very little effect upon him; never slept for more than two hours at a time; pulse always low, and general indications of debility, suppuration taking place from slight causes. The skin sloughing from the smallest injuries.

The day before his death, he was quite tranquil, not rational, but simply quiet and exhausted. These particulars I obtained from Dr. Begley.

Post-mortem.—Skull.—Sero-sanguineous effusion into the sac of arachnoid. Arachnoid white, thick, and opaque. Pia mater rather more than normally vascular. Hemispherical ganglion decidedly more vascular than in health, but not much darker. This increased

vascularity was so irregular, that *the patches gave the ganglion a mottled appearance of purple red color.* Serum in the ventricles clear, but quantity increased.

A bright rose-colored tint is sometimes met with, and always indicates that there had been increased vascular action during life. This color may be seen both on section, and on the surface after the removal of the arachnoid and pia mater. The different layers which compose this ganglion are sometimes unusually distinct; but I have not been able to associate this appearance with any peculiar symptoms during life.

Dr. Bright says* that "a rose tint is sometimes peculiarly distinct on the inner layer, sometimes confined by a distinct line of separation from the outer part of the cineritious substance, at other times imperceptibly shading into it. The one division between the layers is sometimes marked by different shades of the habitual color, or sometimes by dark gray shades from venous congestion, or by the unusual pinkness, either of the external or the internal layers. There are usually three layers, thus pretty distinctly marked, though occasionally the eye is capable of distinguishing six. It is not at all uncommon to find a certain tendency to separate in the external layer; but this is occasionally so marked in elderly persons, and in those who have labored under symptoms of imbecility, as to be obviously a morbid state. In these cases, when the membranes have been drawn off, if a convolution be gently pinched between the finger and thumb, a considerable portion, of about the thickness of a wafer or more, but uniform in its depth, comes away, leaving an even surface. This state of the cineritious substance has appeared to me sometimes to be the result of habitual excess in fermented liquors, and is likewise found where febrile diseases have been accompanied with delirium and tremor. Although this condition of the cineritious substance is by no means uncommon, I do not know of any author who has referred to it, except Dr. Foville."

Cineritious substance is often found of a gray color, approaching in some cases to a deep violet color. Dr. Bright attributes it to venous congestion, and considers that it is sometimes increased by the morbid condition of the blood, produced by its imperfect decarbonization. "The vessels, filled with dark blood, may often be distinctly seen by the assistance of a lens, and the numerous orifices, by which they have communicated with the pia mater, may be seen, of unusual size, upon the surface of the convolutions. This state is usually attended with decided symptoms of congestion, and of cerebral oppression during life; it is occasionally the result of fevers, particularly when they are accompanied with obstruction in the lungs. In cases of bronchitis, in diseases of the heart which greatly obstruct the circulation, and, in cases where suffocation has produced death, we find this gray appearance of the cineritious substance."

The cineritious substance is sometimes of a yellow color, but I have never seen this, except in connection with an alteration in the color of the medullary substance, and I believe it to result from an extension of disease from the medullary. I have seen the change in the latter alone.

The change in texture, as regards softening, varies in degree from

* Reports of Medical Cases, vol. ii. p. 677.

that slight change which is only observable in consequence of its being torn off in small patches, or the removal of the pia mater, and a soft, pulpy state like thick cream. Sometimes, though seldom, it is most unnaturally hard. Dr. Bright has associated this state with old inflammatory mischief of the part, as thickening or adherence of the membranes.

I have occasionally met with laceration of this ganglion, which Dr. Bright was the first to point out as one of the effects of concussion. It shows itself, says this author, "in two ways: by small ecchymoses of clots in the cineritious substance, which are often found in various parts at the same time; or by an abrasion of the surface, which is thus reduced to a pulpy state mixed up with bloody points, giving the idea that the mischief has in part resulted from the tearing off of the pia mater. Convulsion of the features, and of the extremities of the opposite side, is the frequent symptom attendant upon this lesion."

The hemispherical ganglion is sometimes very thin over the whole cerebrum or cerebellum; "but besides that," says Dr. Bright, "I have seen it almost wanting over a small space, where a layer of lymph has been thrown out between the pia mater and the convolutions. In one or two instances I have also seen a clean excavation in the convolutions, as if some portion previously injured or diseased had been absorbed."

Symptoms and Effects of Inflammation of the Hemispherical Ganglion.—We will next consider attentively one of the most important laws of vital action which pathology has yet unfolded in relation to the nervous system, namely, that the first effect of the first stage of inflammation of neurine is to excite and to exalt to an unnatural degree, exactly the same kind of power which we have reason to believe resides in it in a normal state. For instance, the first effect of inflammation of the surface of the brain is to excite the mental faculties, to produce great irritability of temper, and constant restlessness or desire for action. If the inflammation be arrested at this point, the patient recovers his reason; but if it pursues its ravages undisturbed, limiting its destructive effects to the spot where it commenced, without extending to that portion of the brain which is beneath, it annihilates the intellect, but does not affect the muscular system; while, on the other hand, if the inflammation extend further, reaching the instruments by which the will travels to the muscles, it first produces *convulsive action* in these muscles, which afterwards become perfectly paralytic; in this case the integrity of the neurine, through which volition traversed to call these muscles into action, is compromised, and its power, therefore, as an instrument for the production of voluntary motion, destroyed.

The same phenomena are presented to us by observations on the instruments of sensation, as far as we are at present acquainted with these instruments, for we generally find, when inflammation attacks the tract of sensation, (the first symptoms existing a sufficiently long time to be accurately observed,) that previous to the obliteration of sensibility in any texture, the normal sensibility of the part is exalted, the patient suffering the most severe pain both at the spot where the nerves of sensation originate, and in the brain itself where they terminate.

The first effect of unusual arterial action of the hemispherical ganglion is to exalt the intellect; this effect is often so transient that it may be

unobserved. We meet with a good illustration of it in the effect produced by alcoholic stimuli. Up to a certain point they render the individual taking them lively; his ideas come more rapidly and more clearly; he expresses them in better language, with greater facility, and more rapidly; but this effect soon passes off. If the stimulus is continued, the brain becomes oppressed, the muscles of the tongue sluggishly obey the will, and the speech is thick and indistinct; his ideas are confused, his language incoherent; at last he loses consciousness, and becomes wholly insensible to the external world.

As these views are based on a belief in the truth of the two following positions, it will be necessary to adduce further arguments in support of them:—1st. That the hemispherical ganglia are intimately connected with the intellectual powers, and that it is in them peculiarly, and not in the whole cerebral mass, that these powers reside. 2d. That the medullary substance beneath is, in all probability, merely the passive servant, as it were, of the cineritious, either as the conductor of its commands to the muscles, or of the materials, namely, the various impressions made on the peripheral extremities of the nerves of sense, which the cineritious perceives, and with which it works.

Such, as elsewhere stated, appears to be the opinion of MM. Foville and Pinel-Grandchamp, and such also is the opinion of Bouillaud, who, when investigating the localization of the cerebral functions, says,* "If we reflect that disturbance of the intellect can exist independently of every other derangement of the cerebral functions; if we reflect, moreover, that disturbance of the intellect appears to coincide constantly with an alteration of the cortical substance of the brain, we shall be obliged to admit as very probable this double opinion, namely, that the injury of the intellect depends upon that of a distinct part of the cerebral mass, and that the distinct part of the brain the injury of which produces derangement of the intellect, is the cortical substance of that organ." He then refers to the following cases in support of his opinions.

Case 12.—*Alteration of the intellectual functions without lesion of the locomotive functions; then convulsions, grinding of the teeth, loss of intelligence: death the third day. Inflammation, with softening of the gray substance, arachnoiditis.*†—Maintion, 43 years of age, house-painter, married, entered, the 18th of November 1823, the hospital of La Charité: six years ago he left the military service, and had only been in Paris two months. Since two years he had shown signs of imbecility, and had completely lost all memory. Whilst he was a military man, he had shown, at different periods, derangement of the intellectual faculties. Last year, at Versailles, he had symptoms of acute meningitis: two months ago, these same symptoms having re-appeared, a seton was inserted in the nape of the neck: besides, for two years he has complained of constant pain of the head and at the root of the nose, with a smell of putrefaction in this cavity. For a twelvemonth *he has been weak in his legs.* He has always had a good appetite. After having taken cold baths for a month when he was in the hospital of St. Michel, he fell in a state of great exhaustion, and experienced lipothymiæ.

The 17th of November he lost his mind, had repeated attacks of convulsions, with loud and unequal respiration.

The 18th, at ten in the morning, general convulsions; eyes wandering; white froth from the mouth; rigidity of the limbs; sometimes grinding of the teeth and contortion of the mouth; sensibility remaining in the upper extremities, which he draws back when pinched, and makes grimaces; no motion in the lower extremities when pinched, but they are less rigid than the upper. Total loss of intelligence; respiration rattling; pulse pretty strong, full, regular and slow. (*Thirty leeches to the neck, ice to the head, sinapisms to the inferior extremities, a purgative enema.*) The agitation continued the remainder of the day; the convul-

* Op. cit.

† Op. cit., Case XV. p. 85.

sions are universal; the face is red and tumefied, the mouth is deformed, the lips projecting anteriorly. With the ice, the head is exceedingly hot; the forearms are strongly flexed; intellect is entirely lost. He was in the same state during the night.

The 19th, in the morning, the right arm is almost without motion, the left alternately rigid and convulsed; eyes shut; he shuts his jaws when he is desired to drink, and appears to feel a little when the left arm is pinched very hard: slight heat of skin; pulse 112, full and regular. (Venæsect. ad ℥xij. purgative enema, sinapisms, &c.) In the course of the day the patient died in the greatest agony.

Autops. cadav.—twenty-four hours after death. The arachnoid is adhering in eight or ten places in the superior surface of the brain: in removing it, the cortical substance comes away with it in pieces of about the size of a franc, and about a line in thickness; the medullary substance is a little injected. The left lung is a little hard posteriorly, deprived of air, and somewhat hepatized. The right is red, and congested in about the same place. The mucous membrane of the stomach is red in its splenic portion. All the other organs are healthy.

*Case 13.—Alteration of the general intellect from time to time, loss of mind, stupor without paralysis or convulsions; erysipelas of the face, and death.—Inflammation and softening of the gray substance, with injection of the white substance.**—Victoire, 46 years of age, was an infirm patient in the hospital Saint Louis for the last two years. She was subject to *attacks* characterized by a sudden loss of mind, convulsive motions of the lips, and an embarrassment of the tongue analogous to the apoplectic; it was observed that sensibility was almost extinct. At the end of four or five minutes she regained her senses; but she remained as if it were not in her power to move; her looks were fixed, she stammered, and seemed as if she awoke from a lethargic sleep. She completely recovered in about an hour. For some time her courses had been irregular; eight months had elapsed since they had made their appearance. During this time the attacks just described became more frequent, when she was frequently bled from the foot. One day Victoire fell from a height of three feet, and greatly contused her left lumbar region. She merely applied pressure to the swelling. After a time, a phlegmon, which afterwards formed an abscess, made its appearance; the abscess was opened. Shortly after another swelling was formed near to the former: it was also opened; but would not cicatrize. The first wound which was closed soon re-opened, and from that time a very large quantity of pus escaped from this double fistulous ulcer. She was desired to keep quiet; but she began her accustomed work, and for two years nothing particular occurred.

The cerebral symptoms seemed to be progressive. Victoire often complained of headache, and then her face was of a dark red color; she felt some pain in her left arm, which she said wanted strength. Her intellect daily got worse; more stupefied; when spoken to she looked like an idiot, and if asked whether she had heard, she would briskly answer *Yes*, without any other emotion. She was often giddy, and she often seized things to prevent herself from falling. She was losing strength, the circulation languished, the breath was foul, the appetite little altered. With all these inconveniences, Victoire fulfilled her services as night-nurse with an ardent zeal. Being attacked with erysipelas, she was obliged to take to her bed. It was accompanied with great heat, and proceeded slowly. It was œdematous: two grains of tartar emetic produced abundant vomiting; and after this the swelling of the face abated. The secretion of the lumbar fistulæ also ceased. Little attention is paid to this phenomenon: three ounces of manna are ordered, which produce a few stools. The conjunctiva of the right eye then suppurated, for which a blister was applied at the nape of the neck. The patient complained of great pain in the hypogastrium. Manna was again ordered. Nevertheless the suffering increased, and she had no sleep the next night. The next, when I saw her, she was lying on the back, with the head inclined backwards, the face discolored, the lips black, voice almost gone, respiration very difficult, frequent pulse, skin cold. From the dyspnœa, we suspected a latent pneumonia, and then we endeavored to re-establish the running of the fistulæ. For this purpose a large blister was applied, but without any effect, she having died at five in the morning.

Autops. cadav.—twenty-four hours after death.

1. *Cranium.*—The membranes were healthy, except at the superior and middle part of the right hemisphere; there was a slight infiltration of the sub-arachnoid cellular tissue, and the pia mater adhered at this point. The gray substance was natural, but the white injected; in cutting it, the blood flowed from the orifices of its vessels; its consistence was not changed. The gray substance, in the space of three convolutions, corresponding to the spot where the membranes were altered, was of a red, mixed with a yellow color; it had lost the shining appearance of the other convolutions; it was unequal, and, as it were, tubercular, and several small red points were to be seen on its surface. Its consistence was not everywhere the

* Op. cit., Case XVI. p. 88.

same: the superficial layer could easily be removed by the handle of the scalpel, and seemed as if it had been *boiled;* the deep layer was much injected, and was nearly of the same consistence as the neighboring parts. The gray substance was thinner in the extent of the affection than elsewhere.

2. *Abdomen.*—There were evident traces of chronic peritonitis. The abdominal organs presented some peculiarities which it would be useless to relate here.

3. *Thorax.*—The pleura pulmonalis of the left side strongly adhered to the pleura costalis. The left lung was slightly congested posteriorly, and easily torn. The right lung was perfectly healthy. The heart was nearly in a normal state.

The two cases just related are very remarkable, because both the patients show no other signs of cerebral disorder than a slight defect in the intellect. It is known that latterly MM. Foville and Pinel-Grandchamp have maintained that the gray substance presides over the intellectual phenomena, and the white over the movements. If their assertion is correct, it follows, that in both these patients there ought to have been lesion of the gray substance only: this is also what we have seen. It is true that the last patient had general convulsions: but this phenomenon evidently depended on the inflammation of the arachnoid, which showed itself in the last days, and to which she fell a victim.

Case 14.—*Great grief; torpor of the left arm; a stupid and imbecile look; alteration of intellect; loss of the power of speech; death 24th day. Ramollissement of the convexity of the cerebrum, particularly of the gray substance; albuminous granulations, with an ash color of the surrounding parts, and injection of the meninges.**—Mary Morlet, 23 years of age, a laboring woman, strongly built, of a melancholic character, has been constantly fretting for about a year, or since she left her native place. She is taciturn, and for some time has not spoken to the women working with her; for the last four months she has not been regular, which makes her fear that she is in the family way. This idea augments her troubles. Her superior extremity is now in a state of torpor, and she is taken to the Hospital Cochin, the 31st December, 1821.

The 1st of January, 1822, she is very much depressed, and complains of pain all over the body and of torpor of the right arm, symptoms which greatly disturb the patient; she appears stupid; her ideas seem fixed; her answers are not pertinent; her face is without expression; the pulse small, contracted, as if convulsive; the breath slightly fœtid; skin hot and dry, and there is pain in the epigastrium. (*Twenty leeches on the abdomen; lemonade; low diet.*)

No change in the following week. She appeared indifferent to all that surrounded her; she seemed to be consumed by a series of dominating ideas. (*Venesect. at the arm; blister to the nape of the neck; demulcent drink and bouillon.*)

Jan. 9. The patient answers none of our questions, and merely says *Faut-il?* which she constantly repeats in a sad tone of voice; the arm is paralyzed, stiff, and œdematous; the features are contracted, the forehead is corrugated; she coughs, and her respiration difficult; face red, pulse frequent and *irregular;* the pulse consists of a series of precipitated oscillations, separated by very sensible intermittences; face terreous; nose cold and pointed. (*Sinapisms to the feet, which scarcely redden the skin*)

The 10th. Same state. (*Blister to the nape of the neck, which does not take.*)

The 12th. Her physiognomy appears animated; the features are more expanded; she seems to understand what is said to her, but makes no answer, and only says *Faut il?*

The 13th. Urinary and alvine excretions involuntary; sinking; eye fixed; concentrated pulse, soft, slower.

The 14th. More motion of eye; expression not so sad; she smiles.

Same state till the 17th. (*Arnaca; bouillon.*)

The 18th. Sadness returned; eyes black and blue, sunk; same state of the intellectual functions.

The 19th, 20th, and 21st. The depression increased, vomiting. (*Another blister to the head, which does not take*)

The 22d. In the evening, profound coma; little pulse, thread-like, and frequent; respiration plaintive and suspirious; eye widely open, fixed; foolish look, and trismus.

The 23d. Eye fixed and dull; pupils dilated, immovable; respiration noisy, rattling; plaintive sighs; convulsive agitation of the left arm. (*Venesect. in the arm.*) Death at three in the afternoon.

Autops. cadav.—thirty-six hours after death.

Encephalon.—The arachnoid covering the dura mater is healthy; the surface of the brain red and much injected, especially at the posterior convolutions of the right hemisphere; redness and injection, which appear to be owing to the presence of the pia mater, the tissue of which is much gorged with blood. Having removed this vascular network, the surface of the

* Op. cit., Case XVII. p. 93.

cerebral convolutions is covered by an infinite number of clots of blood; concrete albuminous granulations are spread here and there on the convexity of the left hemisphere, and extend to that part of the right hemisphere which corresponds in the middle to the great cerebral division. These granulations are grouped, and, as it were, agglomerated in three principal places, which are the seat of the mischief. The most extended of these groups implicates the two hemispheres of the brain, but the left much more than the right, and it occupies the middle and internal convolutions of the superior surface of this organ: there the arachnoid which adheres to the brain is covered by granulations; it is opaque and thick: beneath it the cerebral substance is softened; its consistence is pulpy, of a gray red color, much resembling the *encephaloid* tissue, softened and combined with a certain quantity of blood. This softening extends about four or five lines in depth, and its longitudinal diameter is from eight to ten lines. The other smaller places present the same characters; the albuminous granulations are of the size of a grain of hemp-seed, and resemble the tubercles often found on the external surface of the intestines. These granulations are found in the seats of the disease, so that there exist at the same time softening and hardening of the cerebral substance. There is here tuberculous and encephaloid-looking matter, evidently produced by phlegmasia. The gray substance surrounding *these parts* is of a well-marked ash-color. The lateral ventricles only contain a few drops of sanguineous serum; the cerebellum and spinal marrow are healthy; the pia mater which envelops them is red and injected.

Thoracic Organs.—The lungs are healthy; the pericardium distended, fluctuating; it extends as far as the right side of the chest, and contains from six to eight ounces of lemon-colored serum. The heart, swimming in this fluid, is not at all changed; its right cavities, gorged with blood, are a little dilated.

Abdominal Organs.—The stomach and small intestines are in a normal state; there are a few ulcerations in the large intestines. *The uterus is healthy.* The tissue of the tube and ovaries is red and as it were erectile: the fimbriated extremity of the tubes adheres to the ovaries, on which it (if I may use the term) is grafted.

In this last case the softening had proceeded slowly; the phlegmasia had certainly been a chronic one, whilst in the preceding cases it had proceeded in a very rapid manner, and the inflammation in general had been of an acute kind: we find the same thing in the following case related by M. Avoyne:

Case 15.—*Cephalalgia; furious delirium; convulsions alternating with a state of collapse: death.—Arachnitis, with softening of the cortical substance of the cerebral hemispheres.**—A. Mahon, 30 years of age, of a sanguineous biliary temperament, having got drunk, fell from a first story, the 1st of January, 1846. No serious mischief arose immediately after the accident; he lost a little blood from the left ear, and cephalalgia supervened, which continued; but on the fourth day it greatly augmented: on that day, towards evening, he was seized with violent delirium, and was admitted into the Hôtel Dieu, where he was tied to prevent his getting out of bed. At the end of the night he suddenly fell into a state of drowsiness. The fifth day the drowsiness was so great that nothing could rouse him; the face, a little pale, had a gloomy appearance; the eyelids were shut; in separating them the eyes were directed to the right side; the head was inclined to the same side, and if this position was changed, it was immediately regained; the jaws were firmly shut; the pulse slow but full; the patient now and then agitated his arms, and sighed frequently. Neither the cranium nor the other parts of the body showed any trace of contusion. (*Infusion of Roman chamomile with tamarinds; blister to the nape of the neck; sinapisms to the knees.*) Drowsiness diminished during the day, without the return of the intellectual faculties; in the evening furious delirium appeared at intervals. The 6th, in the morning, delirium had ceased; drowsiness not so great. He now and then opened his eyes, but soon shut them again: he moved his limbs, but he constantly sighed; the eyes were still directed to the right, and the jaws shut, the face a little discolored. (*Three leeches on each side of the neck, and cupping-glasses on the wounds.*) The patient was sensible of the application of the cupping-glasses, and had no delirium in the night. The seventh day, in the morning, very nearly the same state; sometimes the eyes were open for a length of time, but without sight. (*Hydromel; tamarinds; ice on the head; sinapised fomentations.*) In the evening he began to sink, and continued so till the morning at six, when he died.

Autops. cadav.—The cerebrum was disorganized in many places on its superior surface, and there were collections of blood between the pia mater and the arachnoid. This disorganization, which was only superficial, was rather deep in the posterior part of the posterior lobe of the left side; all the encephalic mass was red, yellow at some parts, and very soft. The lateral ventricles, extraordinarily dilated, contained a large quantity of serum. All the other parts of the body were healthy.

The symptoms in this case did not indicate the existence of an acute inflammation of the

* Op. cit., Case XVIII. p. 98.

arachnoid; but you see that the phlegmasia is not confined to the meninges, since the cortical substance of the superior convolutions of the brain was disorganized in many places, with very considerable injection. The intellectual disorder must be attributed to the irritation of the gray substance which accompanies inflammation of the arachnoid. You are aware that MM. Parent and Martinet have shown, by a great number of facts, that delirium corresponded to inflammation of that portion of the arachnoid which covers the convexity of the brain, which tends to confirm the opinion of those who think that the intellectual faculties reside in the gray substance of the convolutions.

Case 16.—*Contusion of the cranium; no remarkable cerebral symptoms the first days, then furious delirium; coma; death the 20th day.—Abscess in the gray substance of the convexity of the cerebrum; inflammation and disorganization of the arachnoid.**—Antoine Broussart, 65 years of age, having experienced great losses in commerce, and being reduced to great misery, gave himself, on the 6th of January, in the morning, many blows on the head with a hammer; but not succeeding in killing himself, he takes a bad pair of scissors, seizes the right testicle with the left hand, and removes it with the scissors. This furious fellow is mastered, and is taken to the hospital La Charité. On the road he tried, but in vain, to strangle himself. On his arrival the surgeon who was present observed about the line of union of the parietal bones with the frontal, a considerable tumor, which he opened by a crucial incision, to allow the extravasated blood to escape, and to ascertain whether there was any fracture. The next day, the 7th, M. Roux examined the wound, and stated that there was no fracture, and had it dressed in the ordinary way, as well as that of the scrotum. (*Low diet, petit lait emetisé.*) The 8th, no accident has occurred. The following days the patient was getting better, when the wound of the head, which till then had secreted a large quantity of pus, began to get dry. The 20th he fell into a state of coma; his pulse became hard and quick, his skin exceedingly hot; an ichorous matter flowed from the nostrils. To this, furious delirium supervenes; the patient jumps out of bed, threatens his neighbors, wishes to fight them, when he is seized by two nurses, who replace him in bed and tie him to it. He expires in a quarter of an hour.

Autops. cadav.—The dura mater, which is thickened, is covered by a yellow false membrane, and on its internal surface are a few black tubercles; the pia mater is equally thickened; the arachnoid is nearly altogether disorganized, especially between the convolutions of the cerebrum, which are bathed with pus; the superficial layers of this part are softened, and in a state of suppuration: there is nothing else worthy of remark.†

This case confirms what we have already said, viz., that a circumscribed lesion of the gray substance has no direct influence on the movements of the extremities. Effectively, the patient rises in a furious state the day of his death, threatens to maltreat his neighbors, and cannot be kept quiet until he is tied. On opening the cranium, an abscess was found, terminating in the gray substance of the brain. As to the delirium, the agitation, and the fever, they are accounted for by the phlegmasia of the arachnoid.

Case 17.—*Slow answers; alteration of the intellectual faculties; a species of idiotism, without paralysis or convulsions of the extremities; death the 37th day.—Two large abscesses, occupying the middle of the cerebral hemispheres.*‡—A soldier, twenty six years of age, brown, robust, and sanguineous, was in the military hospitals of Pau in November, 1813. At his arrival he said he had been unwell for fifteen days; but, his ideas being confused, this statement could not be relied upon, and he could give no exact account of the phenomena of the invasion. He was tranquil, scarcely answered, the eyes wide open, with a stupid look, and he complained of nothing. He could get up to ease himself. His face was much colored, especially the cheeks; tongue red, abdomen painful on pressure, the skin extremely hot to the touch, pulse rather slow, pretty full and developed, appetite fair.

After ten or twelve days he appeared to be convalescent; but the stupidity and quietude remained. He seldom answered, and with much brevity; he frequently refused to get up, but frequently sat up in bed, and looked stupidly at that which was going on about him. He only spoke when he wanted something to eat, or to satisfy some other want. At the end of five or six days the heat and frequency of the pulse re-appeared; diarrhœa then came on, and the febrile action subsided. The torpor increased, the wants were no longer known, and he died, without convulsions, the twenty-second day of his arrival, and the thirty-seventh of the invasion, according to his account.

Autops. cadav.—Head.—Two large places filled with greenish pus, sticky, and inodorous, each occupying the middle of one cerebral hemisphere, not communicating with the lateral ventricles, but surrounded by a white cyst, formed of a sort of concrete pus easily broken up; with this a considerable injection of all the encephalon.

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* Op. cit., Case XXII. p. 116.

† This case was reported by Dr. Hennelle, then house student at the hospital of La Charité.

‡ Op. cit., Case XXVI. p. 128.

"If we take into consideration these facts," says M. Bouillaud, "which might be multiplied *ad infinitum*; if you remark, besides, that those physicians, who have recently employed themselves in the study of mental alienation, have remarked that it was always accompanied with a disorganization more or less deep of the cortical substance of the superior convolutions of the brain; if you reflect, lastly, that, as has been truly observed by MM. Parent and Martinet, delirium is connected with inflammation of that portion of the arachnoid which covers the convexity of the brain—you will certainly be very much disposed to agree with the opinion of MM. Fovel and Pinel-Grandchamp, which places the seat of intelligence in the cortical substance of the superior part of the brain."

I quite agree with Dr. Abercrombie that it is impossible to separate inflammation of the arachnoid and pia mater, either in diagnosis or in treatment; but I may again add also, that it is impossible to separate inflammation of these membranes from that of the hemispherical ganglion or cortical substance of the brain.

Dr. Abercrombie employed the term *meningitis* to express the disease, meaning thereby inflammation of the arachnoid, or pia mater, or both, as distinct from inflammation of the dura mater.

Andral* says that most of the lesions of which medical men place the seat in the arachnoid are really diseases of the pia mater. In almost all the cases, for instance, where the convexity of the cerebral hemispheres was covered with a layer of serum or pus, this layer had its seat beneath the arachnoid; on passing the back of the scalpel over the latter membrane, the morbid product is displaced, but not removed. However, whilst we admit that in the diseases designated by the name of arachnitis, or more properly meningitis, anatomy discovers lesions in the pia mater much more frequently than in the arachnoid, still we should not assert, as some writers do, that the arachnoid always remains unaffected.

Dr. Abercrombie considered the *phrenitis* of systematic writers inflammation of the membranes of the brain. "It is characterized," says this admirable observer, "by fever, watchfulness, acute headache, impatience of light, suffusion of the eyes, and maniacal delirium. This affection, however, is seldom met with as an idiopathic disease, except in a few cases in which it is brought on by the abuse of strong liquors, and in warm climates by exposure to the intense heat of the sun. As a symptomatic affection, it is met with occasionally in fever, and in mania; and a condition nearly allied to it sometimes occurs after injuries of the head. Circumstances will be afterwards mentioned, which render it probable that in this form of the disease the inflammation is primarily seated in the membranes of the brain. When fatal, it is generally by a rapid sinking of the vital powers supervening upon the high excitement, without producing much disorganization of the parts which appear to have been the seat of the disease; for the cases which are referable to this class, when they terminate fatally, are generally rapid in their progress, and the appearances on dissection are often unsatisfactory. There is an affection of frequent occurrence, which, perhaps, may be referred to this head. It is characterized by a peculiar aberration of mind without any complaint of pain. There is a remarkable restlessness, quickness, and impatience of manner, obstinate watchfulness, and incessant rapid talking, the patient rambling from one subject to another with little connection, but often without any actual hallucination; he knows

* Clinique Médicale Trans., by Spillan, p. 42.

those about him, and generally answers distinctly questions that are put to him. There is a rapid pulse, but without the other symptoms of fever, and the disease is apt to be mistaken by a superficial observer for mania, and consequently to be considered as not attended with danger. But it is an affection of very great danger, and often rapidly fatal. The nature of it is obscure, and the appearance of it on dissection rather unsatisfactory; it consists chiefly of a highly vascular state of the pia mater, without any actual result of inflammation."

We cannot, I think, ascribe the mental disturbance, excitement, excessive pain, intolerance of light, delirium, and insanity, which have been observed as the diagnostic marks of inflammation of the arachnoid and pia mater, to a simple lesion of either a serous or vascular membrane; we are compelled to refer them all to the injury which that portion of the brain that is in contact with these membranes has received from inflammatory action.

Bayle,* in his admirable work on diseases of the brain, strongly supports the opinion that inflammation of the arachnoid is characterized by mental alienation. 1st, he states distinctly and broadly that "most mental alienations are a symptom of chronic primary phlegmasia of the membranes of the brain." He also draws an important distinction between inflammation of the arachnoidea reflexa, or that lining the dura mater, and the arachnoidea investiens, or that in contact with the pia mater and covering the brain. The first he calls chronic or latent arachnitis, the second *chronic meningitis*, because it affects both arachnoid and pia mater.

Bayle considers that a certain number of monomaniacs and melancholic patients have primarily derived the disease from a deep and durable lesion of the moral affections, and to a ruling error which controls more or less the will of the patient, and becomes the basis of an excessive delirium. But he says, "I am far from saying that *matter* has no influence in the development of these species of derangement. I do not speak of their origin, which is purely mental; but we shall see that in certain hereditary and constitutional predispositions, these mental derangements produce upon the brain and its appendages certain effects, which in their turn become a cause of certain symptoms, and that thus there is a re-action of the moral on the physical and of the physical on the moral."

This accords with the affection which I have described as inflammation of the hemispherical ganglion from within as distinguished from *meningitis*.

Bayle considered that some very rare alienations depend on a specific or sympathetic irritation of the brain. If Bayle means that any mental alienation exist without a temporary or permanent morbid concretion of the capillary system of the brain, I do not agree with him.

The more I have seen of the *post-mortem* appearances which are left in cases of mental derangement, the more I am convinced that each form has its respective lesion, though I am far from pretending that they have been all discovered. The signs of meningitis during life are varied and obscure.

* Traité des Maladies du Cerveau et de ses Membranes, par A. L. Bayle, 1826.

Parent Duchatelet and Martinet* divide the stages of arachnitis into three. The first is generally manifested by an exaltation of sensibility, from whence arises cephalalgia, one of its most constant characters. When it is seated at the base of the brain, there is frequently a tendency to drowsiness, which may give place to nausea and vomiting; generally there is some fever. The stage of excitement is very variable in its form, according to the age of the patient, the part that is inflamed, the constitution and the degree of sensibility of the subject of it. Its duration varies from some hours to one, two, three, or four days; sometimes it is prolonged up to two weeks, but this is rare, and the symptoms are then very vague and uncertain. The patients are in a mixed state of health and disease. When this occurs, it is generally in weak cachectic persons, or in infants.

The second period is a true period of reaction, accompanied with disturbance of the muscular system, corresponding to that of the brain, convulsions, delirium, agitation, contractions, oscillation, and the commencement of dilatation of the pupils. In this period the headache is less constant than in the first. This period is usually the longest in its duration, varying from two, three, or four days up to one or two weeks. It presents some differences according to its seat. Inflammation of the arachnoid at the base and in the ventricles is almost essentially combined with convulsions, agitation, affection of the globe of the eye, while that on the convexity or the upper part of the hemispherical ganglion is characterized by delirium.

The third period is the shortest in its duration, varying from some hours to three or four days, rarely prolonged beyond this. It is the period of collapse, of the abolition of the senses, a loss of movement, local and general paralysis, coma. At this period it is difficult to distinguish positively the existence of simple arachnitis. My own observation corresponds with the above authors in the general characters of these symptoms, especially in the distinction between the symptoms which attend lesions at the base of the brain and in the ventricles, from that which accompany inflammation of the upper part of the ganglion. But I do not think they have laid sufficient stress on the mental excitement.

Dr. Neisser† remarks very justly that the symptoms of effusion are sometimes marked by the excitement of the brain resisting the oppressive effect of the extravasated fluid, so that there is a sort of balance between the symptoms.

Andral‡ bears his testimony to the constancy of lesions of intelligence accompanying meningitis; such lesion presenting itself either under the form of delirium or coma. The delirium may present the greatest varieties with respect to its nature; in some it is very violent, accompanied with loud cries, and a great development of muscular strength. In others, on the contrary, it is of a silent description, and the patients appear very

* Recherches sur l'inflammation de l'arach[d]. cerebral et spinal, ouvrage fait conjointement. Paris, 1821.

† Die Acute Entzündung der Serösen Häute des Gehirns und Rückenmarks nach eigenen Beobachtungen am Krankenbett Geschrieben. Von Dr. Joseph Neisser, Prakt. Arzt. zu Berlin, 1845.

‡ P. 56, op. cit.

much prostrated in strength. Sometimes one single idea engages the mind of the patient; sometimes ideas of the most heterogeneous description occupy his thoughts. In some this disturbance of intellect attains its highest degree from the very commencement; in others it comes on gradually and insensibly. On reviewing in each case the numerous varieties of form which the delirium presented, we might arrive at this important conclusion,—that no single one of these various forms characterizes meningitis, that there is not one of them which may not be found in the different cerebral irritations which are purely sympathetic, and unaccompanied with any structural alteration of the membranes appreciable on the dead body.

When once the delirium has developed itself, it may not cease, presenting merely alternations of exacerbation and remission; it may also be only transitory. There are some patients in whom this disturbance of the intellectual faculties is but of very short duration; then at the end of a period more or less long, it returns; the intermissions become more and more short, and at last the disturbance becomes continued. In some the delirium commences only at night, and the clearness of the intellect during the day seems, at first, to exclude the idea of meningitis altogether. In some, a delirium of several days' duration suddenly disappears a little before death, when the other symptoms become more aggravated. Wherefore, when it is attempted to distinguish the delirium produced by meningitis from the delirium produced by sympathetic irritation of the brain, it is wrong to lay it down that the latter only can be intermittent, for numerous cases prove, beyond all doubt, that delirium arising from meningitis may be accompanied with perfectly lucid intervals. The period of the disease at which the delirium appears is far from being the same in every case. Very rarely this phenomenon marks the outset of the malady; so that, in the midst of health, when delirium does suddenly come on, it is not at all probable that it is dependent on meningitis. In the great majority of cases, pain of head precedes it; and oftentimes six, eight, twelve, and even fifteen and twenty days pass on between the period at which the pain of head presents itself and that at which the intelligence commences to be disturbed.

Andral considers that the diversity of the lesions of intelligence in meningitis can only be accounted for by referring to the differing susceptibility of the brain to impressions.

My reason for dwelling so fully on these symptoms of mental excitement as indicative of inflammation of the hemispherical ganglion, is the belief that the *condition* of the intellectual faculties is not sufficiently attended to as part of our chain of evidence when we attempt to diagnose affections of the brain.

We may next consider the various causes which induce meningitis or inflammation of the hemispherical ganglion, (and in using the term meningitis I do so for its brevity,) and the symptoms and circumstances which are peculiar to these varieties.

Concussion of the Brain.—In both a practical and a physiological point of view all injuries of the skull, as productions of meningitis, are especially interesting; almost every case presents some new and peculiar feature worthy of attention. For beautifully as nature has protected

the brain, the bony case which has been contrived for this purpose cannot be seriously injured without some disturbance of the organs contained within it. And we find in practice that all injuries of the skull occasion more or less derangement of the intellectual faculties.

After what has been stated regarding the connection between the intellectual faculties and the cortical substance of the upper portion of the brain, we shall be prepared to observe the effect produced by any serious injury to the textures which are placed in such close contact to this organ.

The most frequent consequence of a severe blow on the head is concussion of the brain. Inasmuch as this injury frequently leads to inflammation of this organ, it will be well now to consider its symptoms.

Simple concussion or shaking of the brain obliterates, for a longer or shorter period, according to the degree of violence, the mental phenomena which are exhibited during a state of health. The patient who, a moment before, was in complete possession of all his mental faculties, receives a violent blow on the head, and in an instant loses his consciousness, and lies dead to the world around him. This result we suppose to depend on the particles of neurine, of which the brain consists, being put into a state of vibration, an effect which interrupts for a time the natural functions of the organ.

The state of insensibility sometimes continues only for a few minutes; in other cases it will last for some days, the patient remaining in a kind of sleep, insensible to *ordinary* stimuli; the eyes, for instance, may be opened in a moderate light, and he will not apparently be aware of the presence of any one; but if a strong pencil of rays be thrown upon the iris it will contract, to prevent too many impinging upon the retina, and he will perhaps turn his head away from the light. A conversation may be kept up by his bedside without disturbing him; but if he is called loudly by his name he gives evidence that he is aware of the circumstance. As recovery gradually takes place, the patient will answer questions, but incoherently, evidently neither understanding their import, nor able sufficiently to collect his thoughts to give a particular answer. If the case proves favorable, these symptoms disappear by degrees, the patient recovers, and no traces of the accident remain. If, however, inflammation supervene, another train of symptoms makes its appearance, and then the consequences are generally fatal.

No one who has once observed a case of concussion can doubt that the intellectual faculties are dependent in some way or other on the brain; but at the same time it is clear that, in a physiological point of view, this is the whole amount of evidence furnished.

It is extremely important in all cases of concussion to be very early alive to the symptoms which indicate the commencement of meningitis. Of all effects of inflammation on the human frame this is most to be dreaded. We cannot be too much on our guard to prevent its intrusion, or too careful in our endeavors to distinguish the symptoms which indicate its approach. When once set up it is difficult to arrest, and when arrested it too often leaves behind it consequences which are felt for the remainder of life. In cases of injury to the skull, the surgeon so much

more frequently observes the effect of injury to the brain as a whole, than merely to the membranes primarily and the hemispherical ganglion secondarily, that he is more in danger of overlooking such symptoms than the physician, whose attention has been directed to this disease in its idiopathic form.

When inflammation follows concussion of the brain, it is more usually inflammation of the substance and the lining membrane of the ventricles than of the cortical substance, and the whole train of symptoms are decided and unequivocal from the first; but sometimes the effect of the concussion passes over quickly, and the patient is considered out of danger; but after a few days meningitis supervenes in such an insidious manner, that it is overlooked by the friends, the services of the medical man not being, as they suppose, any longer required.

I believe that the origin of many cases of insanity might thus be traced which might have been prevented if the first symptoms had received the attention which they deserved.

The following case is peculiarly interesting and instructive in this point of view:—

Case 18.—James Coker, a lad, æt. 14, was admitted into St. Thomas's Hospital, May 9th, 1846, under Mr. Solly, with general symptoms of concussion. About five o'clock in the afternoon, while working as a bricklayer's laborer, on some scaffolding at Woolwich, he slipped, and fell from a height of seventy feet. He fell across a piece of timber, first striking the lower portion of the abdomen and afterwards his head. Mr. Denne, surgeon, of Woolwich, who saw him a few minutes after the occurrence of the accident, states, that he was insensible, pale, cold, and almost pulseless. Warmth was applied to the body, a slight stimulus given, and when reaction had sufficiently taken place, he was sent up to the hospital.

On admission he was partially insensible, answered when spoken to, but in a snappish way, barely answering the question put to him; pulse somewhat accelerated, and fuller than natural; pupils dilated, but sensible to light; skin moist; there was a considerable swelling on the left groin, and tenderness in that region. Ordered, by the house surgeon, cal. gr. iij. stat. Hirud. xij. inguini sinistro.

May 10th, 9½ A.M.—Has passed a restless night, but is more sensible; pulse 100, pupils dilated, countenanee pinched, legs drawn up in bed, crying out as though in pain, swelling in the groin much diminished. Ordered Hyd. c. creta gr. iij. stat. Head to be shaved, Hirudines iij. sing. temporibus; a patient was required to sit by his side to keep him in bed.

May 10th, 9½ P.M.—When Mr. Solly paid his visit to-night, he found him in the following state:—His countenance pinched and anxious, refusing to answer any questions, making use of bad and violent language, and very noisy, disturbing the whole ward. Pupils dilated, contracting sluggishly to the light of a candle, right rather more dilated than the left. He could not detect any local injury of the head, and the patient said he had no pain there. There was some tenderness over the abdomen; he moved his left leg about a good deal.

His extreme irritability and restlessness, and his semi-conscious state, led Mr. Solly to think that some inflammatory action was commencing in the hemispherical ganglia. Ordered, calomel gr. i. quâque horâ, donec alvus soluta sit. postea duabus horis. Hirud. xx. capiti applicand.

May 11th, 8½ A.M.—Not much change has taken place; he has been very restless during the night; his bowels have not been relieved. Still continues violent, obstinate, abusive, and uses most vile language.

The calomel to be continued, and thirty leeches to be applied to the head.

1½ P.M.—His bowels have been freely opened, and a large quantity of solid feculent matter voided.

8 P.M.—Is a little better, more conscious, and quieter, bowels purged, mercurial stools, pulse jerking 144, right pupil rather more dilated than the left. Rept. Hirud. xxx.

Hyd. c. cretâ gr. ij. Ext. Aconiti gr. i. Pulv. Doveri gr. ij. 4ta quâque horâ.

May 12th.—Has passed a better night; quieter, and not so violent, irritable or abusive; in answer to a question, says he is nicely, better, that he has no pain in the head; appears to suffer pain in the abdomen, but does not say so. Emp. Lyttæ abdomini Ung. Hydrarg. Fort. for dressing.

1 P.M.—Sleeping; head rather hot; hands cool; cries out occasionally without any apparent reason; when asked why—does not know. If any pain—answers no. Cold lotion to be applied to the head.

10 P.M.—Much better, quieter, and more sensible.

May 13th, 8 A.M.—Sleeping quietly, rested well during the night, pulse 116, soft; when he awoke he said, Oh, give me somebody to take care of me! When asked why—because I feel so queer; if he had any pain in the head or abdomen—said he did not know. He recognized Mr. Solly, but soon dozed off again.

14th.—Sleeping; when he awoke, said he was quite well; rambling; head very hot; tongue furred; pulse 124. Hirud. xx. capiti. Discontinue the Dover's powder and increase the Hyd. c. cretâ to gr. iij.

Vesp.—Much the same, pulse 120.

15th.—Pale; has been excessively irritable during the night, but not incoherent; much purged; stools bright yellow; pulse 116, irregular, not much power. Pulv. Ipec. Co. gr. iij. 4ta horâ.

7 P.M.—Quieter than usual; during the day less purged. Pulse 124.

16th.—Much the same; pulse 120.

17th.—Improved in appearance, talkative, but still irritable in temper; appears to enjoy his food; pulse 116; bowels regular; tongue cleaning.

18th.—Much better; countenance natural; pulse 104.

19th.—Complains of pain over lower part of belly. Rept. Emp. Lyttæ.

20th.—Free from pain; countenance much the same; pulse 130.

21st.—Better in every respect; wishes for more food, and to get up; pulse 110.

30th.—Is up to-day; complains only of weakness.

June 15th.—He was presented to-day, quite well. It was quite striking the difference in his language and manner. His language, instead of being rude, foul, and abusive, was civil, respectful, and correct; his manner quiet, instead of being excited and snappish. I have no doubt whatever, that if the case had not been treated as one of inflammation of the hemispherical ganglion, but had been passed over because there was an absence of the usual symptoms of serious injury to the head, the boy would soon have been decidedly insane, and then the same measures would have been comparatively useless. It cannot be too often repeated that, when once the delicate texture of a ganglion is in an acute stage of inflammation, it soon becomes disorganized, and all medical treatment is unavailing.

The following short case illustrates very well the ordinary course of a case of simple concussion of a slight character, though the primary effects were so severe that the existence of the patient was in danger:

Case 19.—Wm. Johnson, æt. 30, gardener's laborer, stout, hearty looking man, was driving his master's cart in Bishopsgate-street, December 18th, 1841. The day was cold, and he had been drinking spirits in the morning: when attempting to make some alteration in the harness, he fell from the shaft, pitching on his head; the wheel went over his pelvis as he lay on the ground. I was sent for to see him a few minutes after the accident, in Mr. Beale's surgery, Bishopsgate. He was then quite insensible, pulse slow and distinct, totally unconscious of everything. On examination of the head, I found a spot about the size of a crown, over the superior posterior angle of the left parietal bone, puffed and swollen, but no irregularity of surface indicating fracture. There was much bruising over the right ilium, showing the course of the wheel, without any fracture of the pelvis. I sent him down immediately to the hospital. I saw him there again half an hour after the occurrence of the accident; he now shows some signs of returning intellect by endeavoring to articulate his wife's name, and crying, from a half consciousness of his situation, but he could not utter any distinct articulate sounds, and soon sunk into a quiet insensible state again. Ordered Pulv. Jalap. c. Hyd. Chl. gr. xv. stat. M. S. C. 6ta horâ postea. Hirud. xx. capiti, if his pulse got up in the evening, and the dresser thought he required them.

Dec. 19th.—Quite rational; vomited about two hours after I left. Sister considers he rejected some of the powder; bowels open; leeches not applied. Repeat the powder, and as he complained of some pain on the left side of the head, ordered Hirud. xx. stat.

20th.—Quite well; permitted him to leave the hospital.

The following case from Mr. Abernethy shows the more serious effects of concussion:

Case 20.—W. Thomas, about 30 years of age, fell from the top of a brewhouse, a height of at least 80 feet. His hand being stretched out, first sustained the shock, by which the

carpal bones were separated, and driven upwards, some before and others behind the ends of the radius and ulna; the articular surfaces and periosteum being at the same time forced off the latter bones. I mention these particulars to show the great violence of the fall. The man's head afterwards struck the ground, as appeared by a bruise on his face; but the cranium was not injured. When brought to the hospital, he appeared almost deprived of life, his body being cold and his pulse scarcely to be felt. The gentlemen then attending put his feet into warm water, and gave him an opiate. After this he gradually became warmer, and it was observed that there was not much dilatation of the pupils, and but little stertor in respiration. I saw the patient next morning, at which time his skin was very hot, and he perspired copiously. His breathing was repeated at regular intervals, but the expirations were made with unusual force. The pulse was extremely irregular, both in frequency and in strength; generally about 140 in a minute. His pupils were moderately contracted, his eyebrows drawn into a frown, as if he suffered pain. When I spoke to him softly, he did not answer. I pinched his hand slightly, but he did not move; but when I repeated this a little harder, he drew it away with seeming vexation. He disliked that his eyes should be examined. When, by speaking loud, I roused him, and inquired if his head ached, he answered yes. I got him to swallow some opening medicine, which emptied his bowels; and four leeches were applied to his temples, but they extracted very little blood, and I thought his pulse countermanded any further evacuations.

In the afternoon he appeared better. His pulse was more regular, and his skin of a more natural temperature; his pupils, however, were more contracted, and his sensibility increased. I tried the effect of giving him forty drops of tinct. opii, thinking it might diminish sensibility, and keep him quiet for some time, during which the vascular system (which seemed to be particularly deranged) might, perhaps, regain its powers. The opiate increased his disposition to sleep, and he appeared to suffer less pain; but in the evening his pulse was more feeble and frequent, and his skin hotter, and quite wet with perspiration. Wine was now given to him, but without any apparent benefit; the powers and actions of life gradually diminished, and before morning he died.

On dissection there appeared every mark denoting violent inflammation of the brain and pia mater. The minute arteries of the pia mater were turgid with blood; in many places there was the appearance called blood-shot, which was also to be seen in the lining of the ventricles. Dark colored, and, in some places, bloody, coagulated lymph filled all the recesses between the tunica arachnoidea and the pia mater. On dividing the substance of the brain, all its vessels appeared as if injected with blood.

I am inclined to believe that the medical treatment of the patient did him neither much good nor harm. The means employed seem to have acted on him as on a person in health. The opening medicine rendered him cooler, and quieted a little the disturbed actions of the system. The opiate made him more still, and disposed him to sleep.

I leave it to practitioners to consider whether cordials would have been of any service in this case. Would they not rather, by stimulating the nervous system, have increased the disturbance of the sensorium, and by exciting the heart and arteries, have tended to aggravate the inflammation of the brain?

This case is a good illustration of the consequences of concussion when the disorder is uncontrolled by surgical treatment. Reasoning from what I have seen in other cases, I cannot but think that if the patient had been freely depleted locally and mercurialized, as soon as "his pupils became more contracted," he might have recovered.

I regard this condition of the pupils, taken conjointly with a hot skin, as a very clear indication of the commencement of inflammatory mischief.

I regard the administration of opium in such a condition as decidedly injurious.

Fractures of the skull more frequently than mere concussion lead to meningitis; the inflammatory action passing continuously from the bone and its periosteum the dura mater, to the arachnoid and pia mater.

The following case marks well the train of symptoms which I believe indicate inflammation of the hemispherical ganglion, consequent on fracture of the skull.

Case 21.—Betsey Rankin, æt. 18, was admitted into St. Thomas's Hospital, under my care, as Mr. Travers' assistant, April 20, 1841.

She walked down to the hospital with her mother, and came to the surgery as a casual patient. Her mother stated that she had been thrown out of a swing at Greenwich fair, a month previously to her admission; that she was stunned at the time, and has suffered severely from pain in the head since; but she was not considered severely injured. At the time she presented herself, she exhibited an unnaturally excited appearance of the eye; but her answers to questions were perfectly rational, though her manner was rude and abrupt.

One of my colleagues happening to see the case immediately after she was in bed, before I came into the ward, and believing it to be his own, cut down upon an irregularity, which he found upon the surface of the skull; the pain of the incision made her very violent and disgustingly abusive in her language. The incision permitted the escape of some coagulated blood; the division of the temporal artery gave rise to a free hæmorrhage of about eight ounces. It exposed a fracture extending horizontally through the parietal to the frontal bone, and another running perpendicularly from the above.

11 P. M. Same day. Still very violent and abusive in her language when spoken to, otherwise quiet and dozing; tongue foul; pulse quick. I explained to the sister of the ward that her violent language was to be considered as a symptom of disease, and that everything was to be effected by a soothing system and by kindness. This was scarcely at first understood; but my directions were most fully carried out, and their value afterwards thoroughly appreciated. When I saw her, I ordered Mist. Sennæ Comp. stat. Hyd. Chlorid. gr. ij. quâque tertia horâ.

21st.—Bowels freely opened; last evacuations watery. Her manner is still excited; but she expresses herself much relieved, adding, in a sharp tone, that she only wanted to be left quiet. On account of the diarrhœa, I ordered the calomel to be discontinued, and Hydr. c. Creta gr. iij. 6ta quâque horâ.

22d.—As the bowels are now quiet, ordered the calomel to be renewed; she is rather more rational.

23d.—Bowels relieved, but not purged; complains of pain in her head, which is unnaturally hot. Ordered twelve leeches to be applied, if the sister could persuade her to have them on; but not to use any violence.

24th.—The leeches were applied without much difficulty; her head is relieved, and she is dozing nearly the whole day.

27th.—I made, by Mr. Travers' direction. an incision at right angles to the original one; this caused her to be very angry and violent.

28th.—Better.

29th.—Much better; says that she has very little pain in the head, and no heat; ordered a little fish. Her conduct and manner to-day were quiet, natural, and well-behaved. I found her in the middle of the day sitting up in her bed, knitting.

May 1st.—As she was not quite so well to-day, exhibiting some of her previous excited manner, and fearing return of the inflammation, I ordered, as I did not think her constitution would bear any more calomel, aconite gr. ij. t. d. Hirud. xij.

8th.—Pil. Hydr. gr. v. ter in die. Quite rational; says her head is quite well, the wound healthy and discharging freely.

11th.—I ordered her sarsaparilla and the blue pill to be given twice, instead of three times a-day. The aconite was also omitted, from there not being any more ready at the shop.

12th.—Exceedingly violent and excited about her mother; ordered Hirud. xij. The effect of the leeches was very decided, and sleep soon followed their application.

13th.—Manner not so quiet or natural as previous to the omission of the aconite; ordered to resume the aconite.

This last medicine was continued, with small doses of blue pill, until the 29th, when she was dismissed quite well. Her manner was modest and unassuming, and she expressed herself exceedingly grateful for everything that had been done for her in the hospital.

The surgeon often witnesses inflammation of the dura mater, seldom as an idiopathic, or spontaneous disease, but generally either the consequence of syphilis or of local injury.

Dr. Watson* considers that the dura mater may be inflamed while the pia mater remains unaffected; and that the arachnoid may suffer inflammation and leave the subjacent pia mater untouched. Whether the arachnoid ever escapes participating in the inflammation of the dura

* Lectures, Med. Gaz., vol. xxvii. p. 170.

mater on the one side, or the pia mater on the other, is to be doubted. "But it seems to me scarcely possible that inflammation of the pia mater should take place without implicating also the surface of the convolutions."

I agree with Dr. Watson in his opinion regarding inflammation of the dura mater; but I doubt that the investing portion of the arachnoid is ever inflamed without the pia mater being more or less implicated, and with it the hemispherical ganglion. I have long felt convinced that there is no such thing as inflammation of the pia mater independent of the brain, and that much mischief has accrued from our systematic writers treating of inflammation of the membranes of the brain as distinct from inflammation of the brain itself, instead of distinguishing between inflammation of the hemispherical ganglion, the tubercular portion beneath, and other cerebral ganglia.

Dr. Watson, in his lectures,* relates the following case, which unequivocally illustrates his opinion that inflammation of the dura mater may be confined to it, and the reflected portion of the arachnoid, and not extend to the pia mater or brain.

Case 22.—A man came to the hospital to have a small incised wound of the scalp looked at. The injury appeared trivial; the cut was dressed, and the man made an out patient. A few days afterwards he came again perfectly paralytic on one side of the body. I saw the man's skull trepanned; he was perfectly calm and collected: that part of the dura mater that corresponds to the wound was inflamed, and there was pus effused over the arachnoid, covering the cerebral convolutions on the same side. He sank quietly into a state of coma, and so died. Not the slightest incoherence or delirium had been manifested; there had been no convulsions, nor was there any other morbid appearance within the cranium.

Inflammation of the dura mater sometimes occurs continuously from the petrous portion of the temporal bone and the lining membrane of the internal ear; and sometimes without any disease of the bone, it extends along the sheath of the auditory nerve. This affection is not uncommon among the poorer classes and those whose diathesis is strumous. It occurs more frequently in childhood than in either adult, or old age. Its progress is very gradual and insidious. The knowledge that such a consequence may result from otitis or inflammation of the internal ear, should make us very careful in our treatment of this affection, and very guarded in our prognosis. I have found that the best treatment in such cases, is to use very mild and unstimulating lotions, and even these very carefully; counter-irritants behind the external ear, and anti-strumous medicines, of which none are equal to the cod-liver oil.

I remember having a case of chronic otitis under my care at the Aldersgate-street Dispensary for some weeks, without being able to effect any improvement until I gave her the cod-liver oil. She recovered rapidly with this medicine, and the discharge disappeared without any local treatment.

The subject of the following case I saw only a few days before her death, but it illustrates the insidious and fatal character of the disease.

Case 23.—*Otitis terminating in abscess of the cerebellum.*—Phœbe Whittington, aged 5 years, had had an occasional discharge from the ear ever since her birth; but the mother says, that she was always a very lively, healthy-looking child, and never appeared ill until seven days

* Med. Gaz., vol. xxvii. p. 771.

previous to my seeing her, at which time the discharge stopped, and she then complained of ear-ache.

I first saw her on Wednesday, the 17th; she then looked pale and in pain, but not *diseased.* I discovered a small fluctuating tumor behind the right ear, over the temporal bone, about the same size as the external circumference of the ear. The skin was not discolored. The head was violently drawn back, and the sufferings of the child were evidently very great. I opened the swelling with a lancet, but I had to divide it very deeply to reach the matter, as no absorption of integument had taken place. The pus was excessively fœtid. I ordered a simple aperient. The following day, finding the child but little relieved, I ordered her small doses of gray powder with a slight sedative; but she remained in great pain, screaming violently till about twenty hours before her death, when she became comatose, and died just ten days after the invasion of these fatal symptoms.

Post-mortem.—Cerebrum presented no morbid appearance; layer of pus under the tentorium; abscess in the cerebellum; thickening of the neurilemma of the auditory nerve, whole sheath filled with pus; dura mater covering the posterior face of the petrous portion of the temporal bone separated from it by pus. The surface of the bone not carious, only denuded.

The abscess formed a thick layer on the centre of the right lobe of the cerebellum, occupying, in a horizontal plane, nearly the whole of the outer circumference of that lobe, and extending across the mesial line a little way into the left lobe. The neurine round the abscess was not altered in color for more than a line or two at the most.

Labyrinth of the ear filled with pus, and the whole disorganized.

I considered that this case was originally one of inflammation of the lining membrane of the ear, which extended along the neurilemma of the nerve to the cerebellum, inasmuch as the temporal bone was not diseased, nor the dura mater covering it.

Inflammation of the dura mater may spring from syphilis in two ways; first, and most commonly, as a continuous inflammation from a diseased cranium; secondly, from the direct action of the poison, as in other fibrous tissues and periosteal membranes in other situations: in the latter instance it assumes much of the rheumatic character, and requires to be treated like rheumatism in other parts of the body, only more actively.

In considering the hyperæmic affections, and the effects of hyperæmia of the dura mater, we must not omit osseous deposits. The dura mater, it must never be forgotten, is the nutritive membrane of bone. Its vessels sometimes, like vessels in other situations sometimes, overdo their duty, and the bone is deposited in small patches. This deposit is not confined to that portion which lines the skull, but it is not unfrequently found on the falx and tentorium. It always acts more or less as an irritating body.

Case 24.—When dressing for Mr. Travers, in 1823, a man was brought under my care who cut his throat in a watch-house. He died; and when we were making an examination of his head in the dead-house, on mentioning that he had been an extremely irritable, violent-tempered man during life, frequently illustrating the old line, "Ira furor brevis est," Mr. South said, "look particularly at his dura mater, and see if there are any osseous deposits." In this case there were rough bony deposits on the falx major.

Since then I have frequently remarked the same connection between this morbid growth and mental irritability amounting to insanity. The following is one among many others which I might detail:—

Case 25.—J. L. had been peculiar in his habits and manners during his whole life, but latterly it became necessary to place him in an asylum, from the sudden outbreaks of violent temper over which he apparently had no control. In the intervals between the paroxysms, which were very uncertain, he was rational, though latterly he became *rather* imbecile. The paroxysms were easily excited by any slight circumstances which annoyed him.

He sank more apparently from the effect of the intestinal than the cerebral disease.

Post-mortem. 24 *hours after death.*—Weather cool—March 1839.

Skull.—External appearances.—Supra-orbitar region fully developed, frontal region rather small, occipital and posterior parietal full and large.

The bones generally much thinner than usual, especially in the frontal and temporal regions.

Dura Mater.—External surface healthy; ossific deposits on its visceral surface. These were three in number, situated very near to the longitudinal sinus on the right side; the most anterior of which was situated opposite the coronal suture, about the size of a large pea, but with sharp, irregular-pointed edges; the next, about an inch behind, the form of the letter Y, about an inch in length, an eighth of an inch wide, very rough; the posterior patch was much like the anterior.

Cerebro-spinal fluid in very large quantities under the arachnoid. The convolutions on the upper part of the anterior lobes slightly atrophied, their surfaces pinched up, and the fossæ wide.

Cerebellum full and large.

In tearing off the pia mater, portions of the hemispherical ganglion were removed with it, in consequence of some softening of its texture, more particularly in the neighborhood of the osseous deposits.

Three layers of cineritious neurine were distinctly visible in this ganglion. The external, the darkest; the middle, the lightest in color; the most internal, the next in tint to the external. The white fibres, running through them, were beautifully distinct.

Chest.—Viscera healthy.

Abdomen.—Flatulent distension of the colon; ulceration of the mucous membrane of the ilium, close to the ilio cæcal valve.

The extreme thickness of the skull, which is not unfrequently met with in insane patients, must be regarded as the result of long-continued and general hyperæmia of the dura mater.

The spiculæ of bone which are found sometimes shooting from the internal surface of the skull, though scarcely coming into this category, deserve mention here. There is generally an abnormal development of normal projections; we meet with them not unfrequently springing from the temporal and parietal bones in the temporo-sphenoidal fossæ. I have seen them in cases where they have evidently lacerated the brain after a severe blow has been struck on the skull. The brain, in such cases, is shaken violently and moved within the skull, so that the sharp projecting spiculum is jerked out of the fossa in the brain in which it lies quietly at rest, and lacerates the brain on the side. The following case illustrates this, and also organic disease, in connection with which subject, I shall again have occasion to refer to it.

The anterior and posterior clinoid processes are not unfrequently so abnormally developed that they act as irritating extraneous bodies. They have frequently been considered as the proximate cause of epilepsy, and they have certainly been often found diseased in this formidable complaint. I had the opportunity of making a *post-mortem* examination in the following case, through the kindness of my friend, Mr. Ebenezer Smith, of Billiter Square.

Case 26.—E. W., aged thirty-two, suffered from epilepsy since she was twelve years of age. The first attack followed a blow on the back part of the head, occasioned by a fall; latterly the fits occurred very frequently, four or five times in the night, with an occasional interval of four or five days. Her temper was excessively irritable, and her mind had gradually become imbecile. She died during the fit, apparently in a state of asphyxia.

Post-mortem.—Sub-fascial cellular tissue of the cranium abnormally vascular and firm. Bones of the skull vascular, compact, and thick, particularly at the centres of ossification in the frontal and parietal bones.

The frontal bone in the mesial line thin. Vessels of the dura mater enormously distended; bled very freely on separating it from calvarium. Arachnoid slightly opaque. Vessels of pia mater very full of blood. Fossæ digitatæ between the convolutions in the parietal and frontal regions large; cerebro spinal fluid abundant. Cortical substance of the cerebellum rather darker than usual; the medullary more vascular; the whole rather soft. On making a section of the centrum ovale, we were struck with the distinctness of the line

of demarkation between the cortical and medullary substance, both of which were very vascular; softening of the fornix. Choroid plexus large, and almost fleshy. In the right temporal sphenoidal fissure we found an abnormally developed mammillary process, about the sixth of an inch in length, sharp at its point, but wide and broad at its base, projecting like a spine from the squamous portion of the temporal bone; and on the middle lobe of the brain, corresponding to this projection, there was distinct softening of the cortical substance.

No other cavity examined.

Inflammation of the dura mater must always be treated actively. If it is not arrested in an early stage, it soon runs on to the other membranes, and thence to the hemispherical ganglion. Sometimes it stops short of the brain, but causes fatal effusion from the arachnoidal surface.

The following shows the disease advancing from syphilitic affection of the cranium. I had the case under my care in Job's Ward, St. Thomas's Hospital.

Case 27.—The patient, named Hawkins, had not long been suffering from secondary syphilis. He had been in the house some months before he came under my care. He had necrosis from nodes of portions of the frontal and parietal bones, but without any symptoms of cerebral disease, or even irritation.

I happened, however, to remark to the pupils, that such cases were not unattended with danger, as inflammation of the dura mater, arachnoid, and pia mater, sometimes suddenly supervened, and that the patient would then sink from such effusion; about two days after this I was called to him, in consequence of his becoming drowsy and stupid: when I arrived I found him not quite insensible, but scarcely able to answer any question when roused, and when left undisturbed, he was in a semi-comatose condition. I immediately ordered five grains of calomel every four hours, a blister to the back of the neck, and to be dressed with the strong mercurial ointment; he got rapidly worse, and soon became quite insensible; but in twenty-four hours the mercury began to take effect, and it was most delightful to see the rapidity with which the cloud was again removed from his intellects; in forty-eight hours he was sensible enough to answer questions, and ultimately quite recovered. It was also interesting to observe an immense improvement in all his syphilitic symptoms. His nodes became healthy, and some large rupial sores which he had on his thighs and legs began to heal, and progressed most favorably. Previously to this attack, he had been taking the iodide of potassium and sarsaparilla, and a generous diet.

Inflammation of the dura mater, followed by fatal effusion, sometimes arises from traumatic necrosis of the cranium.

Case 28.—On the 19th of January, 1843, a seaman, of the name of John Richardson, was admitted into Abraham's Ward, St. Thomas's Hospital, under the care of Mr. Tyrrell. He was 34 years of age; he had an extensive sore on the forehead, at the bottom of which there was a large piece of blackened dead bone. The appearance presented was so characteristic, that I had a drawing made of it immediately.

He stated that he had received a blow on the forehead, from a piece of log-wood, when in the ship's hold, six years previous to his admission; he was stunned by the blow, and had not been fit for much hard work since. On admission, he complained of pain in his head, but there were no symptoms of any cerebral mischief.

The treatment during the short time he was in the hospital, for he only survived seven days, was alterative medicines internally, and poultice to the wound.

On the evening of the seventh day after his admission, a sudden change took place, the discharge from the wound stopped, and the offensive smell ceased; he became insensible, and sank, quite comatose, about five the next morning.

There was no raving, no delirium, slight muttering, as if he were scolding somebody. From the commencement of these symptoms he was never sufficiently conscious to answer any questions.

No *post-mortem* examination.

I have seen in the venereal wards of our hospital rheumato-syphilitic inflammation of the dura mater pass on to the brain and produce insanity. The following case is a good illustration of it, and the value of active treatment:—

Case 29.—Henry Glazier, æt. 25, a bricklayer, of unhealthy aspect, pale complexion, and spare frame of body, was admitted under my care, as Mr. Green's assistant, into Job's Ward, on the 1st of February, with iritis and secondary eruptions, for which calomel and opium were administered, so as to affect the mouth, and he rapidly improved. He appeared to be in his usual good health till Wednesday, when the sister observed something sharp in his manner, and a wild expression of countenance. The same morning he left the ward without his hat and coat, and remained out the whole of the day, the weather being very cold and wet; he returned in the evening, and complained of pain in all his limbs; it was found that his knees and ankles were swollen and red; he passed a sleepless night, frequently changing his position in bed, and occasionally crying out with a loud voice. On the following day the joints were free from all swelling; the man, however, when questioned as to pain, complained of headache; the expression of his countenance was vacant, wild, and suspicious; he said that he had committed some crime. and that he ought, therefore, not to lie in bed, and it was with difficulty that he could be prevailed upon to do so; he refused to take any nourishment or medicine, but he answered questions that were put to him quite correctly, though during the day he was sometimes so obstinately silent that no answers could be elicited from him. The pulse was quick, but soft and compressible; the tongue furred and moist; the heat natural; the bowels open; no intolerance of light or sound. I told the pupils that I considered the man was suffering from inflammation of the membranes of the brain, caused by metastasis from the sudden recession of rheumatic inflammation.

It appears that the habits of the patient have always been regular and temperate; none of his family have suffered from insanity. He was ordered Pulv. Jalapæ c. Cal. ℈j. M. S. C. Liq. Amm. Acet. ʒfs. Vin. Colchici ♏xl. Mag. Carb. ℈j. Aq. Menth. Pip. 6$^{tis.}$ horis. Venesectio ad ℥viij. Cal. gr. v. 4$^{tis.}$ horis.

28th.—On the following day he was quiet and composed; he no longer refused to take his food or medicine, and he said the headache was better. The same afternoon, however, the symptoms returned, and he was inclined to be violent. The bowels had acted freely.

Ordered Emp. Lyttæ nuchæ. Ung. Hydrarg.

℞. Aconite gr. j. Hyd. c. Creta gr. v. 6$^{tis.}$ horis.

Morphiæ Hydrochlor. gr. j. o. n.

Ext. Colchici. gr. iij. 6$^{tis.}$ horis.

March 1st.—Appears to-day quite comfortable; the countenance is nearly natural, and he passed a good night; he makes no complaint.

4th.—He has continued improving daily since the last report; he now appears to be perfectly rational, and he sleeps well.

Ordered Hyd. c. Creta gr. ij. 6$^{tis.}$ horis. Beef tea, Vin. Colchici ♏xx.

No change occurred in this patient's progress; he perfectly recovered, and went out quite well.

I have no doubt that chronic inflammation of the dura mater is a very frequent cause of insanity. The skull is so frequently found thickened and vascular, as well as the arachnoid, after death in these cases, that the condition of the skull should always be noted in seeking for morbid lesions to account for irritation of the hemispherical ganglion.

I have selected the two following cases from many which I inspected at Hanwell. The facts are interesting in a phrenological point of view, though of course they prove nothing unless they are supported by many such cases. It has not fallen to my lot to observe others in support of the phrenology of the subject, but I give these, as I recorded them at the time.

Case 30.—*Thickness of the os frontis producing melancholia.*—Hanwell, March 2d, 1841.—Death from fever supervening on melancholia, during which the patient was almost constantly crying and moaning; she could only make incoherent replies. During the febrile excitement she occasionally gave distinct answers, and protruded her tongue when requested.

History of case unknown.

Post-mortem.—28 hours. Body much emaciated.

Cranium exceedingly thick in the frontal region, especially over the organs of mirthfulness, ideality, and hope, where it was nearly a quarter of an inch in thickness, as proved by perforating it with a gimlet, and measuring the section. The rest of the skull was slightly

thicker than natural, especially the anterior portions of the parietal bone, as shown by the great depth of the arterial fossæ.

Brain.—Fibrous neurine more vascular than natural. Cineritious substance of the anterior convolutions decidedly darker than natural, and much more so than the posterior.

Weight of brain and cerebellum, 2 lbs. 13 oz.

Lung.—One tubercle, in the lower portion of upper lobe of right lung.

Liver.—Peritoneal covering slightly thickened by white deposit. Pancreas firmer than usual.

Remarks.—I consider that in the preceding case, the disease commenced with chronic inflammation of the dura mater, covering the anterior part of the brain, producing, as in ordinary cases of periostitis, gradual thickening of bone, and that the thickened bone, pressing on the organs of ideality, mirthfulness, and hope, and partially on the reflective organs also, gave rise to the peculiar form of insanity—melancholia. The absence of all appearance of maniacal excitement was to be accounted for by the absence of all appearance of inflammation of the arachnoid and pia mater. It is very much to be regretted that there was no early history of the case, either as regards the probable cause of the disease or its progress.

The following case, derived from the same source, appears to me confirmatory of this view :—

Case 31.—Hanwell, April 1st, 1841.—John Buckingham, æt. 48. Insane ten years. Mental imbecility supervening on anxiety.

Post-mortem.—37 hours.

Head.—Skull generally thick at the anterior part; arterial fossæ numerous and rather deep. In the centre of the frontal bone it was two-fifths of an English inch in thickness (4 French lines). Dura mater strongly adherent to the skull.

Brain.—Cortical substance pale, softening of that portion of the longitudinal commissure called the septum lucidum.

Weight of cerebrum and pons, 3 lbs. 6 oz. Cerebellum and medulla 6 oz.

Death from excited hydrothorax, atrophy of right ventricle of heart, disease of liver.

Sometimes these cases are most obstinate and obscure.

Case 32.—I had under my care a poor fellow, in the venereal wards of the hospital, whose sufferings were excessive. When I first prescribed for him I did so under the belief that he had this form of inflammation, but finding that all the remedies which I have ordinarily found successful in the treatment of these cases, such as mercury, leeches, and the iodine of potassium, entirely fail, I thought I must have mistaken the case; and as there were no cerebral symptoms, I ventured to prescribe for him such medicines as are beneficial in neuralgia, but without any improvement. Having failed in all my endeavors to alleviate his sufferings, I got one of our physicians kindly to take him under his care, who salivated him most freely; but he kept getting worse, at last becoming paralyzed on one side of his face, and totally deaf. The disease, however, stopped here. He did not lose his intellect, or become more paralytic.

Among the causes of inflammatory affections of the brain we must not omit the poison of scarlatina.

Sometimes the brain is attacked in the first instance, before the eruption appears; and sometimes, the eruption not appearing at all, the nature of the case is misunderstood. I knew one family in which three children were carried off, in the course of a few days, with cerebral symptoms, which could not be accounted for until the fourth child exhibited the true eruption of scarlatina. In these cases depletion must not be attempted, but everything to determine the poison to the skin.

The sequelæ of scarlatina are, however, every now and then most formidable in relation to the brain. Every practitioner has seen these cases. The patient is apparently recovering from a mild attack of scarlatina, when suddenly he is seized with headache and blindness, with or without convulsions. These symptoms may have been preceded by the anasarca which frequently follows scarlatina, and on that account, says Dr. Abercrombie, "are apt to be ascribed to sudden effusion in the

brain; but the disease is entirely inflammatory, and the patient can be saved only by the most vigorous treatment, by blood-letting, purgatives, and other similar remedies." It should, indeed, be borne in mind that all the sequelæ of scarlatina are inflammatory; the anasarca quite as much so as any other.

Inflammation of the Hemispherical Ganglion from within.—There is perhaps no single cause which so frequently produces inflammation of the hemispherical ganglion or meningitis as sudden emotion, whether of joy or fear. The latter is, however, much more common. Dr. Abercrombie and Andral relate several cases.* The remedial treatment should be *physical*, though the cause is *metaphysical;* moral treatment alone will not arrest inflammatory action.

The pathological state must not be lost sight of on account of the metaphysical state.

When inflammation of the hemispherical ganglion is excited by moral impressions, the existing cause of the attack travels through the nerves of sense from without inwards, centripetally. It ought to be distinguished from those attacks which are induced by external causes, such as those we have just been considering.

The following cases will illustrate what I mean by inflammation of this ganglion from within—inflammation induced by impressions carried to the brain by the nerves of sense, giving rise to unnatural and undue action of the organ.

In the second of these two cases I believe that the inflammation was of a very low and feeble character, not confined to this ganglion, but extending to the tubular substance and lining membrane of the ventricles, and accompanied by some serous effusion.

Case 33.—Inflammation of hemispherical ganglion produced by fright.—On the 2d of June, 1842, I was called by Mr. Wildbore, of Shoreditch, to visit Miss E. R, who was suffering from cerebral symptoms. I found her lying in bed; countenance pale and anxious; pupils dilated, and sluggish to the stimulus of light. When I first inquired if she had pain in the head, she said no; but after she had raised herself and lain down again, she complained of violent pain; pulse 84, and small; head hot; tongue furred, but not dry; understands what is said to her, but answers slowly.

History.—She was a nervous person when in health, and naturally rather irritable and excitable. She went to Greenwich fair unknown to her parents, and therefore concealed her illness. When at the fair she was suddenly pushed by a stranger to make her run down the hill. She fell, was not hurt, but much frightened, and made excessively angry. She was menstruating at the time. She continued to cry and sob hysterically for seven or eight hours afterwards, and for three weeks she seemed to brood over it, getting gradually worse. She would not complain; but her sister remarked that her head was drawn back. When asked why she did so, she said it was so heavy. She also became silly in her expressions, excessively irritable, sullen, and taciturn. She said that when her head was on the pillow, she could not raise it again; she also complained that everything she saw became double its size, and fiery; when lying in bed she would scream out that she was falling.

Considering from the symptoms and previous history, that the case was one of meningitis, we ordered Hydrarg, proto-iodide gr. j. and a large blister with 60 leeches to her head.

2d day, ½ past 9 A.M.—Has not slept much during the night; complained a good deal of her head; pupils very much dilated; anxious when spoken to, but every now and then jumps up, and cries out, as if frightened; complains of her head, and pain in the ball of the eye; says to those about when speaking in their ordinary tone, "Don't holloa so;" shows immense muscular power in her arms. Emp. Lyttæ to be dressed with mercurial ointment, and as there was difficulty in getting her to take pills, we substituted Hyd. bichlorid. gr. $\frac{1}{16}$ 4^tis^ hor. in mint water. Hirud. xx. to the head.

* Dr. Prichard (op. cit., p. 371) makes some interesting observations on this subject.

10 P. M.—Has been much quieter, and apparently more easy, after the application of the leeches.

The same principle of treatment was carried out, and she ultimately recovered, but it was ten weeks before she was well, and her memory has been deficient ever since. She did not menstruate for four months.

Case 34.—*Nervous fever succeeding to natural labor, after many days' congestion of the brain supervening, with probable effusion.*—C. J. B., æt. 36, the wife of a medical man in the country, was delivered of her fourth child, January 2d, 184–, after an easy and natural labor of six hours. The child was large, and she being, to use a common and well-understood term, constitutionally weak, her husband gave her, towards the completion of delivery, about an ounce of sherry in a little hot water, at short intervals, the effect of which stimulus was obvious in expediting the expulsion of the head.

Having lost by death her preceding infant at the age of eleven weeks, from some congenital defect in the organs of circulation, she was now, and had been heretofore, acutely anxious about the welfare and survival of the present child. Her former nurse, a decided favorite, had been ailing for some weeks, and it had been doubtful whether she would be able to wait upon her at this period. On this point the patient had been solicitous, more for the child's sake than her own, as she naturally enough believed that no other person could take the same care, or do equally well. The nurse, however, now attended, much to her patient's delight.

The after pains were more severe than before, and for this reason the liquor opii sed. was given, and repeated more frequently, together with some hyoscyamus and morphia, during the two first days. They did not, however, succeed in procuring much, or good, sleep, and induced a numbness in the hands and face, which rather alarmed so timid a patient. With this exception, and the circumstance of there being (as on the two last similar occasions), considerable relaxation of skin, evinced by copious and warm perspiration, everything went on as satisfactorily as could be desired for three days immediately following her delivery. Some little mental disquietude was yet perceptible, at the nurse displaying signs of severe illness. Lactation was, nevertheless, very good, as also was the lochial discharge; and aperient medicine had, to all appearance, its proper effect upon the bowels. The child was very healthy, and afforded no cause for extra attention.

We now arrive at a particular point of our patient's history. Early on the fifth day the nurse announced to her that she was compelled, from increasing infirmity and suffering, to give up her situation. This, in the patient's own words, "gave her quite a turn." The best substitute that could be found was obtained, but she was a woman of inferior intelligence, and wanting in the art of pacifying the child as readily as her predecessor. Not being also similarly expert in the various little offices incidental to the lying-in chamber, and those which the patient requires from her monthly attendant, she failed at first to inspire much confidence; and it may be here added, that she gave no better satisfaction afterwards. No bad consequence was, however, yet observable; for during the three or four subsequent days the patient began to take light animal food and broths, as she had usually done—one day partaking of partridge, another of pheasant, and the third of hare, whilst on the tenth day she was allowed about ℥iv of porter, and a mutton chop; of the latter she ate scarcely half, but enjoyed her porter. During the intermediate days (from the fifth, namely to the tenth) she had not slept well, disturbed partly by the child's crying, but excited rather from this circumstance, by want of confidence in the fresh nurse, which feeling had been gradually growing upon her, although the cause was really more in her own fears than from incapability on the part of the woman.

On the 15th of January, this state of nervous irritability had much increased, every cry of the child seeming to aggravate it, so that the nurse and child were removed to another room, but without ultimately producing any improvement in the matter. All matters connected with the uterus were quite satisfactory. There was no abdominal or hypogastric tenderness. The lochial discharge was naturally subsiding, but had not ceased altogether. The milk was certainly diminished, but not more than might have been expected from the diminution of nutriment, in consequence of the total loss of appetite which had ensued. She both experienced and expressed great fatigue in nursing the child, which, as was to be expected, was not satisfied.

After this period, anorexia persisted, along with nausea and tendency to sickness, and there was considerable derangement in the excretions from the bowels. One or two grains of calomel, carried off by half-ounce doses of senna mixture (her ordinary quantum), brought away, in seeming plenty, disordered stools to the amount of four or five each time. Still, the impression was strong upon her mind that the bilious matters required more calomel. The pulse had varied from 110 even to 140, evidently kept up by mental, or more properly nervous, excitement. The perspirations had subsided, but an undue temperature of the skin complained of, which was also sensible to the touch; the tongue exhibited posteriorly a

rough white fur, though not thick; some thirst; there was frequent headache, not of long continuance, attended by a feeling of faintness. She had taken no sustenance besides gruel and tea, with a very small quantity of bread and butter, or biscuit; as other substances, even weak broth, gave rise to most unpleasant heat, in addition to their being loathed. Under these circumstances, I prescribed the Hydr. c Cretâ, gr. viij; with gr. v. of Pulv. Rhæi. One dose of these she took on the morning of the 16th, but failing to operate by the evening, it was then repeated: this also producing no effect, on the following morning half an ounce of black draught was quickly succeeded, as before, by seven or eight evacuations of a foul and offensive character. The slight indolence of the bowels just mentioned disconcerted her not a little throughout the 16th, and then excessive action next day, conjoined with this disturbance of mind, manifestly depressed, still further, her reduced strength. The nervous symptoms previously marked were also aggravated. These were, deficiency of memory, great anxiety, and timidity regarding her own state of health, though not expressed at the time, yet plainly indicated by countenance, manner, and watchfulness, but not what could be called restlessness, nor was there any complaint of want of sleep; she expressed herself rationally.

January 18th.—The nervous irritation was unrelieved, as likewise the concomitant febrile excitement. The bowels had been freely acted upon by saline aperient medicines, but during the day she made complaint of pain and sense of obstruction at the lowest part of the sacrum, accompanied by endeavors at expulsion, as if there was some lodgment in the rectum. An enema of plain warm water was used in the evening, and some softened scybala passed in the night at three different times. She was much alarmed by the passage of these. But the enema, when repeated on the following morning, brought nothing further away, save the small amount of mucus adhering to the bowels.

About the middle of this day (the 19th) she felt suddenly more faint, and twice expressed the fear that she was dying; nervous symptoms much the same, and general debility such as to oblige her being carried out of and into bed, during the few minutes occupied in making it up. For the last two days she was unable to nurse the child, not unwillingly on her part, as the exertion was too great for her, and the breasts had become more and more empty. Indeed, for these reasons, the child had been gradually, and by longer intervals, kept from the mother, and, being healthy and thriving, gave rise to no anxiety; of course, the breasts were now relieved artificially of their contents.

Ordered Magn. Sulph. ʒi. Liquor Amm. Acet. ʒiij. Sp. Ætheris. Nit. ʒi. Mist. Camph. ʒvj. 6tis. horis. Also a night draught, containing, in addition to the above, five grains of Dover's powder.

This latter procured an excellent night's rest, and in the morning (20th) the pulse had fallen from 110, and upwards, the day previous, to 84, was soft and compressible, and continued so throughout the day. She complained of nausea and headache, and refused her morning tea, but the manner was nearly natural again, and she spoke of herself as much better than she ever expected to be; the bowels were freely moved, but the secretions too dark and offensive; nourishment was obviously required, and towards the latter part of the day more was taken than for several preceding days, in the shape of arrow-root and gruel, in the last of which, she had, at two different times, altogether nearly ℥ß. of brandy. Notwithstanding this, there existed much confused sensation in the head, the sequel of the morning headache, not severe, and nausea, resulting, in her opinion, from the anodyne; the latter, of which she expressed a great horror, was not repeated at night, as she felt inclination to sleep, and did sleep naturally from eleven to three.

21st.—At the last-mentioned hour she awoke with intense pain in her head, but did not send for her husband till seven o'clock. He found her more excited than ever, and most apprehensive about herself; the pulse was again above 120, but not hard or full, though certainly approximating to these characteristics for the first time; tongue as before; thirst rather urgent; considerable heat of skin; general expression of countenance anxious, especially indicated by the eye. Supposing the present pain to be still referable to the opiate, and the bowels not being so fully opened during the last twelve hours, the saline draughts were repeated more frequently, and front part of the head covered with rags wetted in cold vinegar and water. The secretion of milk, though slowly diminished, was still going on in the breasts, which were regularly drawn, and there was no cessation of the trifling and natural lochial discharge. The milk had lost its sweetness, and was more pale than natural.

A drowsiness, manifestly increasing, was noticed in the afternoon, and she, when interrogated, stated that she had less pain. Deafness came on rapidly in the evening about six o'clock, and by this time, unless aroused, she seemed wholly unconscious and unobservant of external matters. The aspect of the eyes still betrayed anxiety, and a stare was now perceptible; the irides were naturally contracted, and there was no increase of conjunctival vascularity. The head was hot, and the carotids beat forcibly. Her position in bed was easy, and on the side. Pulse at 130, rather thrilling, very regular respirations, 40 in the

minute, somewhat nasal, with the alæ nasi contracted and visibly in motion; tongue, heretofore moist, had a tendency to dryness, and to assume a brown color. Bowels had been twice acted upon during the day, the stools the same as before, and after each she said she experienced relief in the head. The urine had not for the last twenty-four hours been so plentiful as of late, and, in fact, might be pronounced scanty; about five ounces, perhaps, in this period.

A large blister was applied over the entire cervical spine at seven o'clock, when she had become flushed, and more heated, and more thirsty. Two grains of calomel, with three of James's powder, were administered. The latter was directed to be repeated every three hours, along with the saline draughts and ℥fs. of Mist. Sennæ two hours after the calomel; at nine there were noticed slight catchings of the hand and forearm, and also twitchings about the mouth. Six leeches were immediately put on one temple, and obtained the desirable quantity of blood; the blister was rising well; deafness was more marked, and the drowsiness augmented; but consciousness, when she was roused and spoken to, was apparently unaltered, though her natural quickness of manner was lost, and had been going probably for the last six hours. On the side of the head, opposite to that on which she was lying, a small blister was placed behind the ear, and upon the temple; about twelve o'clock, she took diluents and the medicines readily from her husband, whose voice alone she recognized, but refused them from others.

Up to this period the patient had been under the care of her husband and his partner.

At 4 A.M. of the 22d, the exhibition of mercury was advised by Mr. Wickham, of Winchester, and calomel was given in two-grain doses every two hours; the head was shaved, and slightly enveloped in cloths wrung out of iced water. The condition of the eye was then unchanged, but all the former symptoms were continuing, and, if possible, aggravated, excepting the subsultus, which was visibly abated; congestion of blood in the brain was considered to exist by Mr. Wickham and the other surgeons. They agreed as to the danger to be apprehended from *effusion* on the one hand, and, on the other, from depression of the vital powers (never other than feeble in this patient, as before stated) by mercury, and the other remedies necessary. Had she not been in this doubtful state, Mr. W. thought the pulse would have justified further abstraction of blood, even from the arm. This, however, he could not recommend, but he would not hesitate to resort to leeches again, if the power of the pulse continued much longer unabated. It should have been mentioned, that by the hour of his visit the pulse had acquired a hardness, and increased thrilling. In the supply of nourishment. the greatest caution was hereafter requisite. The strength was to be supported by beef-tea, and arrow-root, and other farinaceous substances, in quantities to be regulated by the pulse, heat of skin, and degree of cerebral symptoms. Dry warmth was applied to the breasts, which had been drawn twice in the previous six hours, and yielded each time upwards half an ounce of milk. At 8 o'clock A.M., the flushing has subsided simultaneously with diminution of carotid action and the absence of pain, and the whole face became pinched and shrunk, and deathly pallid; the tongue had not become dry; pulse and respiration the same in frequency; the former less thrilling, and the latter remarkably gentle and not so nasal. All three blisters had risen, and discharged copiously. In this state of apparent depression she continued for the next twelve hours, with the alteration of a flush, lasting about two hours; between two and four o'clock equally conscious, though incapable of returning answers quite coherent, when excited to take food or medicine, and as easily aroused for this purpose. But, these times excepted, she lay throughout the whole day on her side as before, utterly indifferent to all things and persons around her, with the eyes constantly closed as if in the softest sleep, whilst this state of heavy drowsiness recurred directly after she had swallowed either food or medicine. These she still took most readily from her husband, and in quite sufficient abundance. Several copious evacuations had passed involuntarily from the bowels, of the former appearance; and urine also more freely in the same way. An evaporating lotion, composed of spirit and muriate of ammonia, was substituted for the iced water, and compound spirit of æther was dropped upon the scalp at short intervals, the heat of head being undiminished, as also the excessive carotid impulsion. A second large blister was applied over the upper site of the former, at the nape of the neck, at six o'clock, and the former remedies had been regularly exhibited.

23d, 8 A.M.—About ten o'clock last night her husband had great difficulty in rousing her to take sustenance, on two separate occasions, and at intervals of only a few minutes; and when she temporarily awoke out of this stupor, or extreme somnolence, the stare was more strongly visible, though the pupils were naturally susceptible of contraction, and the eyes indicated no other morbid or unnatural expression. Pulse between 120 and 130, less powerful, but not soft; respiration 36; flapping of both cheeks during each expiration, attended by an audible purring sound; this peculiar state of breathing lasted not above a quarter of an hour. Considerable flushing of the face succeeded to this, with increase of general heat, and force of pulse, as well as rapidity. Two grains of ammonia had been given twice,

nearly an hour apart, while the depression attendant on that special state of respiration lasted. The blister was taken off at twelve, and had produced a good quantity of serum. The remedies have been persisted in, with the cautious supply of nutriment, and at two o'clock she displayed some excitability. She moved the lower extremities about in bed, and asked questions in a loud tone, but incoherent manner, of the two female attendants beside her. Her husband at once stilled her, and of him she took slight notice, and began to make inquiries in a mode different from that recently shown. Since then a return of general sensibility has been perceptible. Pulse now 120, firm, and rather hard; respirations reduced to 34, and quite regular, also freer; had been now and then slight sighing, and stertor; three dark motions, the product of calomel, have been voided involuntarily, with a good deal of flatus; urine passes also unrestrained. Nourishment to be taken less liquid, though thirst is urgent; this is to be relieved by effervescing draughts, *ad libitum*.

8 P. M.—Through the kindness of Mr. Solly, who accompanied him, Dr. Cape visited the patient about six o'clock. In addition to the plan we were pursuing, he prescribed Camphor two grains, reduced to powder, with spirit of wine, and carefully rubbed down with mucilage, so as to be suspended in the fluid form, with eighteen minims of tinct. Hyoscyami, every three hours. The margin of the lower gums evinced slight redness, although the calomel affected the bowels a good deal. During the day the pulse had fallen to 110, but had lost little of its power, and the respiration was now at 30. On first seeing her, Dr. Cape found the pulse at 120, but on re-entering her room about an hour afterwards, it did not exceed 108. There was exhibited on the tongue, still moist, a trifling copper colored fur, attributed to the local as well as a general action of the calomel. Soothing and cheering words have visibly had an excellent effect upon her the last four hours, and the comfort and consolation Dr. Cape afforded her, by confidently assuring her of recovery, were evidently particularly exhilarating. The disposition to sleep was yet strong, and as there were no longer the same heaviness and hebetude in its character, now nearly natural, it was evidently refreshing, and, when asked, pronounced it such herself. Of course the strictest quietude has been observed throughout, and was now more requisite than ever. In the morning she had complained of shortness of breath, but there was no dyspnœa observable, and the feeling passed off after two small doses of ammon. carbon. The nutriment was as dry and astringent as she could take, namely, beef tea thickened with isinglass, arrow-root and biscuit boiled into jelly. She now requested frequently to have her thirst satiated by the effervescing medicines.

24th, 8 A. M.—The calomel has been latterly given every three hours, as its general lowering influence was manifested in the system, and the local action on the gums was commencing. Pulse about 108, or rather below this number, softer, and less resisting; respirations 26 and 24; more free, and natural; surface of the body and limbs warm, the heat having diminished; bowels acting freely, the dejections dark, and containing mucus; passed but little urine, though feeling desire to do so: has been conscious when evacuating. The restoration of consciousness and general sensibility is still more perceptible, together with more normal voice and manner. She says her head feels dizzy, and acknowledges some pain about the forehead and occiput, and also that from the blistered surfaces. Shows aversion to light, but no intolerance of sound; expresses comfort from the ether and cold applications to the scalp, and begs often for them to be re-applied; calls likewise for the effervescing draughts to allay the great thirst, another subject of complaint now made by her.

8 P. M.—Symptoms have continued improving; in addition to the matters complained of by her this morning, she feels the griping of the bowels, and lays it to the effervescing (or "lemon") draughts, of which she objects to take more. She being unable to void urine, after frequent and anxious attempts, about a pint was removed by the catheter, clear and healthy, at one o'clock. Pulse averaging from 98 to 108, much softer, and diminished; breathing nearly natural; has enjoyed much calm and quiet sleep, to which there is a great readiness, but not the previous constant strong inclination. Our former remedies have been persevered in as yesterday, except the effervescing draughts; and the beef-tea, arrow-root, &c., have been daily taken.

25th, 8 A.M.—Since 12 last night, the calomel has been given in one-grain doses every three hours, as by that hour the gums were whitened, and, in the judgment of Mr. Solly, and her husband, the force of the circulation was materially arrested. She is still very sleepy; skin moist, and breathing natural; bowels moved freely in the last 24 hours, and evacuations, as was to be expected, the same. No urine has been discharged, but the bladder is not distended, nor uncomfortable; some tenderness, however, on pressure over it. Pulse 98, during sleeping; open and soft; when she is roused, about 108; tongue moist, and inclining to whiteness; the flushings have recurred occasionally, but more slightly; heat of head externally not diminished, and the ether and evaporating lotion are equally grateful: the thirst has been less urgent, and the saline draughts, therefore, unnecessary; otherwise, the diet and medicines have been the same.

8 P. M.—She has had no calomel since nine this morning, as its effects have become more apparent in the mouth, and the odor of the breath. The bowels, too, are a good deal irritated, but there is not much complaining from this cause; feels her head dizzy, and occasional trifling pain therein. Pulse 98, soft but not flagging; skin comfortable; the camphor and hyoscyamus have been taken, but no other medicines; rather more than a pint of urine was drawn off again at two P. M., previously to which she had expressed considerable uneasiness.

26th, 8 A. M.—It was necessary to draw off the urine again this morning, at two o'clock, in consequence of the patient having made painful efforts of expulsion—there was about a pint, and equally clear; motions from the bowels continue of the same nature, and very copious and watery; she is generally conscious when passing them. Pulse 96, unaltered in character; soreness of the mouth complained of; tongue white, and more furred, and the gums more affected; sleepiness undiminished, but sensibility and sensation obviously increasing. There has been no further occasion for calomel; the camphor, &c., has been regularly exhibited, and the saline draught once or twice.

8 P. M.—There has been less disposition to sleep, and a very perceptible acquisition of sensibility and memory. The bowels have not been so much acted upon, and she has voided urine by her own endeavors. Pulse, during present sleep, 90. By her own desire, she has partaken of more nourishment during the day, and has shown improved strength; one large watery stool was discharged this afternoon involuntarily.

27th.—Was permitted to sleep for five hours together last night, as she rested so tranquilly and naturally; there has been considerably less flushing. Pulse 90, not weak; but soft, and with nearly a natural stroke. The fæces and secretions of urine have been passed consciously, and the former, more sparingly and fewer, changing gradually to a lighter green, are now yellow. Has eaten a little sopped bread at her own request, and could have taken more but from the increasing soreness of her mouth; on this latter account, she finds the effervescing medicine again agreeable; the camphor and hyoscyamus are continued every four hours, with the former allowance of beef-tea, jelly, arrow-root, &c. In proof of returning sensibility, it may be mentioned, that she, this morning, sent her nurse up into the nursery to bring her word how the children were, and made many inquiries, and gave directions then in her usual manner, as well as respecting some other affairs; and, in proof of strength, also, being gained, when it was necessary, last night, to arrange her bed, she experienced far less fatigue from being moved than on the day only previous.

28th.—The strong disposition to sleep is wearing off, though she continues perfectly quiet; says she can hear better, and shows some slight intolerance of sound, but has sensibility to light. The wet cloths are also uncomfortably cold, and the heat of head not now being greater than natural, they are omitted. Pulse 80, during sleep, 90 when awake, quite natural; bowels still relaxed, but the fæces natural; passes urine by herself, and in plenty; there is slight vertigo, together with occasional uneasiness, referred to the head; but she may be now pronounced perfectly conscious, and free from the least aberration of mind, though the power of recollection is very feeble. She displays some anxiety concerning the future management of the child, but this has been apparently allayed. Camphor, &c., to be taken at intervals of six hours, and the diet more astringent; mouth and gums relieved by gargling with the chlorides in barley water.

29th.—Has had less sleep, both by night and by day; pulse and other symptoms as yesterday. Chief complaint made of the mouth, which looks well; bowels restrained, and voids her urine without difficulty. Both takes and has desire for more nourishment. Continue as yesterday. Hydr. c. Cretâ gr. iii. Pulv. Rhæi. gr. v. ft. Pulv. hâc nocte sumend.

39.—Some nausea and pain were produced by the powder, but subsided as soon as the bowels, which have not acted for 36 hours, were moved by it. Has had four stools, relaxed and quite healthy. Pulse as yesterday; there has been scarcely any sleep in the night, from the disturbance just mentioned, but is now sleeping tranquilly; gums and mouth rather better, and she feels appetite.

This patient perfectly recovered, and is now well and hearty too, 1846.

Early in the year 1845, when the railway mania was at its height, I was requested to visit a gentleman at an hotel in the City, who was quite insane. When I entered the room he immediately ordered, in a loud authoritative tone, his attendant to leave the room. He looked at me to know if he was to do so, and as I was quite sure that I should be of little service if I did not obtain the confidence of my patient, I immediately assented. My patient, who was a fine tall muscular man, was lying on the sofa; he now rose and asked me what I wanted. I told

him that I came to prescribe for him, as I understood that he was not well. He then asked me if I was a physician or a surgeon. On my informing him that I was the latter, he said, "Very well, that will do; they are not humbugs generally." He then said, "But I want no medical advice; I never was better in my life," and began talking incessantly, telling me he had made an enormous fortune in railways, and how the Almighty had enabled him to do so. His conversation was rambling, incorrect, and founded on the most absurd delusions. His head was hot, and his face flushed, and he had had no sleep for several nights. I learned that he had first shown decided mental derangement only a few days previous to my visit. Morphia had been administered in large doses, but without the slightest effect. He was always worse at night. I ordered forty leeches to the forehead, fomentations to promote bleeding, and afterwards cold lotions; five grains of calomel with rhubarb and jalep, and a second draught in the morning. I found him more tranquil the next day, having had about an hour's sleep. I repeated the leeches and the calomel. On the third day he was so rational and quiet that he accompanied me in my own carriage, the attendant riding on the box, to a cottage in the neighborhood of the Regent's Park. Here I pursued the same plan of treatment, leeching the head freely, but always first persuading him that they were necessary for his recovery. Each night he got a little more sleep, though it was slow in returning. About the fifth night he slept quite naturally, and without a grain of opium in any form. I gave two grains of gray powder, with a grain of aconite, three times a day. He took a great deal of exercise, and recovered perfectly in a fortnight from the date of my first visit.

If a different course of treatment had been pursued in the case, I have very little doubt he would have been rendered a confirmed lunatic. If, for instance, the strait waistcoat had been applied at night when he was noisy and riotous, instead of being soothed and talked to kindly, or if he had been confined in one of the old-fashioned insane establishments with barred windows and bolted doors, the disease would have been confirmed, and the brain most probably irremediably injured. Harsh treatment to a lunatic produces as much mischief to his inflamed brain as the jolting of a wagon without springs would to a compound fracture of the leg.

I have had three very similar cases, all of which recovered under the same general plan of treatment.

The following, from Andral, is a good case in illustration of the fact that the cerebral circulation may be suddenly excited by an impression from moral causes carried centripetally.

Case 35.—*Apoplexy with Hemiplegia in consequence of fright.*—A robust, and rather plethoric woman, thirty-eight years old, was in perfect health, and speaking to a neighbor, when her servant girl frightened her by brandishing a bright spiral wire over her head, so as to make it look as if a snake were falling on her. In her fright, the woman suddenly fell down as in an apoplectic fit, and remained for some time nearly unconscious. When examined, she complained of a noise and beating in the left side of her head, deafness of the left ear, and of blindness and loss of taste on the same side. She could not move any part of the left side of the body, and in every respect resembled a patient suffering from hemiplegia, in consequence of sanguineous apoplexy. By active antiphlogistic treatment, and various other measures, she was gradually restored from this state in about three months.

Worry in business, mental anxiety, and vexation of spirit, will sometimes bring on spasmodic action of the muscles, and paralysis. In some cases the anxiety and mental irritation induce disease in the hemispherical ganglion, seriously affecting the temper, but not affecting the intellect. Such cases are familiar to all practical men, but it is very difficult to explain their pathology. I suppose that the disease or diseased action excites unnaturally the tubular neurine, which, commencing in this ganglion as the motor tract, conducts the will to the muscles; and the consequence of this excitement is an irregular supply of stimulus to the muscular system exhibited by the twitchings and spasms. This irregular action the mind can more or less control and arrest when awake; but as soon as sleep takes place, then the spasms commence. I suspect that epilepsy is a form of this irregular innervation, only that in epilepsy the nervous or electric fluid *accumulates* in undue quantity, and passes off in a large quantity at once, like the discharge of an electric battery. In many cases of epilepsy, the discharge takes place in small quantities both before and after the complete fit. I have two patients under my care now who suffer seriously in this way: one, a single man, has always warning of the advent of the fit by twitchings of the right leg as soon as he drops off to sleep; the other, a married man, has these twitchings so constantly in bed, that his wife is often kept awake during a whole night. In the non-epileptic cases, though electric fluid is secreted in undue quantities, still it does not accumulate, so as to produce a complete convulsive fit, but is constantly oozing out. Whether this idea is correct or not, it is difficult to say; but the following case will, I think, show that it is of value:—

Case 36.—A medical man, aged 40, nervo-sanguineous temperament, who had been engaged in practice for some years in the North of England, consulted me in the spring of 1842 with the following symptoms:—Some numbness down the right leg and arm, dragging of both lower extremities, but especially the right. This partial paralysis was so severe, that it was with difficulty he walked a mile; on going to sleep, his limbs started so violently as to wake him. He gave me the following account of himself. General health in every respect was quite good until four months ago; when one night, on dropping off to sleep, a sudden catching up of the thighs came on; soon after this the starting affected the whole limb. This condition came on four or six times every night before going to sleep. There was also numbness of the right thigh and pain in the course of the sciatic nerve, odd erratic thrills of pain in the muscles of the same side and head. No convulsive action of the upper extremity at any time. Walking soon fatigued the right leg. On napping after dinner, these startings always came on, so that he often stood up to be free from desire to sleep.

Stomach and bowels in good condition. He went to the sea-side about six months after the appearance of these symptoms, and by the advice of an eminent physician and surgeon, took Pil. Hyd. gr. v. t. d., and applied blisters to the spine, and a seton in the neck, which remained two years. He was much relieved from the catchings, but reduced by the treatment. During the summer the lowering effects of mercury were overcome, and he attended lightly to practice, but in the autumn the symptoms were renewed. He says, "I dragged on through the winter with feeble power, irregular muscular convulsions, and pain in the course of the sciatic nerve." Early in the spring his medical friends urged his giving up practice for a year or two. Up to this time his complaint had been considered *spinal*, and the counsel he received was often contradictory; one very eminent surgeon recommended tonics and to live well; another considered it spinal irritation reflected from the digestive organs.

After conversing with him for some time, and knowing previously a good deal of his mental and moral qualities and excitable temperament, observing the way in which he was constantly putting his hand to his head, impelled by a feeling of uneasiness there rather than severe pain, I felt convinced that the affection was cerebral, and not spinal.

In a consultation which I had with two of those medical friends under whom he had been before seeing me, I urged my reasons for so thinking, and they acquiesced in my view of it. Previously they had recommended a voyage to India as surgeon to the vessel; this

was with the view of saving unnecessary expense. On this I remarked that if he did so, the sailors would drive him mad. I urged, that the only chance of saving him from actual mental derangement was *entire* rest of mind and abstinence from *bodily fatigue.*

The observation that I made with regard to the sailors, of course, was not repeated to him; it was, therefore, curious that in one of his letters, written during the course of the next summer from Jersey, he should have said—"I have often felt the wisdom of your urging me not to take the voyage to India; the worry of the crew would have bothered me to death."

Without going through *all* the details of his progress, I will quote a few passages from his letters written during his absence from home. Italics my own.

June 3d, 1842.—"During the month I have been from home I have experienced little, if any, mitigation of the convulsive catchings which come on as I am passing into sleep. The uneasiness of the head remains the same, and the sense of heaviness or confusion under much fatigue or excitement. *The leg is much better*, and were it not soon fatigued by muscular exertion, I think I could walk as well as ever. My spirits are generally good, and my general health may be called excellent. I continue the gr. ij. of blue pill every night, which you will remember I recommenced at your suggestion near three months ago. I keep the head shaved, and commonly sit without my wig."

July 4th, 1842.—"I certainly am not worse than when I wrote a month ago; I have continued the blue pill till the last few days; I now substitute the sarsaparilla with liq. hyd. bichlorid. The gums have been slightly tender; I have felt very feeble, and since your last favor have most carefully avoided fatigue; I rarely get up till twelve or one o'clock. The iodine has been painted over the whole of the shaved scalp even to your heart's content; and much smarting every other night and a plentiful exfoliation of cuticle does it keep up. I have little other pain; the right leg gets numb now and then, and would, I dare say, if I tried to walk much, soon tire. Writing gives me some uneasiness of head, &c. The 'catchings and jerkings' of the body come on every night on my going off to sleep. This condition abiding, I must deem myself about *in statu quo*, though the quietude I cultivate and the discipline I undergo, through your most judicious advice, must be favorable for damaged structure to recover its original condition."

August 1st, 1842.—"When I was in Dublin I was induced to see Graves. He said I should not continue longer the mercury, that it had done its work right enough; that if I was to be opened at once, no disease would be discovered; he supposed chronic arachnitis had existed, &c.; bade me take Argent. Nit. gr. ¼ t. d., avoid wine and eggs, take a tepid shower bath daily, and continue the seton.

"I have the last few days suspended the bichloride of mercury; I have had four months of it and blue pill, but I have not taken the nitrate of silver. Graves says you know it is a tonic which does not determine to the head. What say you?"

I wrote to him saying that I had no objection to the Argent. Nit., but I was doubtful of its being of service.

He began it, and continued it for about three weeks, but it did not seem to agree so well with him as the mercury.

About the 18th of August I wrote to him, recommending the application of four leeches every night for a week, the bleeding encouraged by exhausted glasses.

One or two moderate doses of salts in the morning.

"Under this plan," says this gentleman in a letter I *lately* received from him, "the head was *much relieved* in so marked a degree that I dated recovery from this period. Leeches were applied over and over again at intervals for many weeks, eight or ten at a time. It always appeared to me that the leeches and the small doses of mercury did a vast deal of good, but the 'catchings' *were not* cured by them.

"Through the autumn and winter while in Spain the same treatment was more or less adopted (dry cupping often over the scalp), but the blue pill gr. iij. was left off; resumed again in January in small doses, and continued ten or twelve weeks.

"I returned to England in May, 1843, in every way very much improved—*well*—except the occurrence now and then of 'catchings.' The last three years I have been in general good health; but have the jumpings come on very much after fatigue or worry, or *tea* before going to bed. Now, October, 1846, I feel generally *as well as ever;* have been so for the past year; and during the last month have often walked for four, six, or eight hours a day, with gun, and powder, and shot, with *ease* and *enjoyment*, but the *catchings are not gone clean away.*"

Mr. Dunn, of Norfolk Street, has related a most interesting case in the twenty-fifth volume of the Med.-Chir. Transactions, which corroborates my view of the pathology of the above case. Dr. Dunn's case is well worthy of perusal in full, but I shall only refer to those points which

bear upon the present division of our subject. The patient was a little boy two years old, a fine, intelligent child; the first indication of disease was a change in the disposition of the child. From being a happy, placid child, he had become irritable, peevish, and petulant, impatient of control. This was going on for four months before the parents, intelligent people, considered the child bodily ill, requiring medical advice. Mr. Dunn was called to him six weeks previous to death. He had awoke as usual, between six and seven o'clock in the morning, and his mother was alarmed by observing his left hand begin suddenly to twitch and jerk convulsively. The intellectual faculties were not then affected; the child was laughing and talking, and perfectly sensible. The child had fallen down stairs fourteen days previously to this attack. On the third day from first occurrence of the convulsive action of the arm, Mr. D. observed an imperfect paralysis of the hand and arm. On the fourth day the convulsive jerkings were not confined to the arm, but involved the whole of the left side and lower extremity, with twitchings of the eye and angle of the mouth. These fits increased in violence. Towards their termination, (and they lasted about two hours,) he cried and screamed violently, but throughout their continuance he was sensible, and could at times be soothed by kind attentions from his parents. The fits were followed by profound sleep for several hours, and the side was left partially paralyzed. The paralysis was not persistent. A few days previous to his death, the right side was also affected. He had these convulsive attacks, with slight intermissions, throughout the day before he died, screaming violently at intervals. The rest is given in Mr. Dunn's own words:—

"The head was hot, faee flushed, pulse hurried, pupils dilated, eyes squinting, and turned inwards, insensible to light, eyelids eonstantly open, and only at times reeognizing the persons about him. On the subsidenee of one of these attaeks, he gradually sunk, at a quarter past four o'eloek on the morning of the 15th of November.

"I was assisted in the *post-mortem* examination of the brain by Dr. Todd and Mr. Bowman, of King's College, and I am indebted to the kindness of the former distinguished physiologist for the following aeeount of the morbid appearanees.

"The sealp was pale and bloodless, like the rest of the body, whieh was mueh emaciated. The dura mater healthy. The vessels on the superfieies of the brain were tinged with dark blood, but there was no sub-araehnoidal effusion. The araehnoid eavity was natural. On the surfaee of the right hemisphere of the brain, both under the araehnoid and pia mater, there was a deposit of tubereular matter in patches of irregular shape and size, but the whole oeeupying a surfaee of about two inehes square. The deposit was most abundant on the surfaee of the eonvolutions; it nevertheless deseended into the sulei between them, a eireumstance whieh proved its connection with the deep surfaee of the pia mater. The eortical substanee of the brain in eontaet with the tubercular matter was reddened and greatly softened; and, on mieroscopie examination, evineed a nearly total destruetion of the tubules in it; a great enlargement of the proper globules of the gray matter, and of the pigment granules which adhere to them. The softening extended a slight way into the subjacent white matter. On the edge of the left hemisphere, eorresponding to the diseased patch of the right, a slight tubercular deposit had taken plaee in a similar manner, producing a red softening of the gray matter in eontaet, but not occupying more than half an ineh square in surface. The ventricles contained more water than natural—about double—and did not eollapse when laid open. The eerebral substanee throughout, exeepting at the diseased part, was firmer than usual at the patient's age. This firmness was no doubt owing to the eompression of the fluid, whieh probably at an earlier period of the disease was more abundant.

"It is, I believe, generally admitted that irritation of the membranes and eineritious substanee of the brain is attended with eonvulsions, without deeided or persistent paralysis, and that it requires the medullary matter to be involved to render the paralysis permanent. My own observation, so far as I have had an opportunity of investigating this interesting subjeet, accords with this opinion. In the present case, the paralysis was not persistent until after

the violent attacks of cramp, and from this time may probably be dated the implication of the medullary substance in the inflammatory process. Admitting the justness of the view, that red softening of the brain is the result of chronic inflammation of its substance, persistent paralysis was not to be expected until the inflammatory action had involved the medullary substance.

"On comparing the two hemispheres, the diseased portions and parts adjacent, the left presented evidences of more recent inflammation than the right; and this was to be expected from the history of the case."

Thus I think it may be considered established that meningitis, though always accompanied with derangement of the mind and temper to a greater or less extent, is in many cases accompanied with derangement of the motor powers. The character of these lesions of motion depend upon the extent of the disease. In the early stage, before it has advanced far, different kinds of spasms exist, from a mere trembling or subsultus tendinum up to the most violent contractions.

"Convulsions, properly so called," says Andral,* "are among the most common phenomena accompanying acute meningitis. These are sometimes, though very rarely, general. When partial they are sometimes confined to the same part, at other times they affect different parts of the body successively. The parts most usually affected with convulsive motions in meningitis are, the globes of the eyes, the eyelids, the face, the lips, and finally the extremities. Tonic spasms, as they are called, are not less frequent than clonic, in the disease now under consideration; thus permanent flexion of the forearm on the arm is often observed. Retroversion of the head, its inclination to the right or left, are sometimes observed in cases of meningitis, as also tetanic rigidity of the neck, trunk or extremities, trismus, &c.

"Under the second class, in which motion is diminished or altogether destroyed, may be reckoned those numerous varieties of paralysis observed in meningitis. This paralysis may affect the muscles of the eye, of the eyelids, face, lips, or limbs; either one or several of these may be deprived of motion. In these different parts the paralysis may be established either slowly or as instantaneously as the loss of motion succeeding cerebral hemorrhage. The paralysis may supervene from the commencement, or succeed one of the forms of spasms already mentioned; it may alternate with these spasms; it may, in fine, co-exist with them; and we have witnessed, more than once, one of the upper extremities completely deprived of motion, whilst the other was more or less violently convulsed. There are also some cases in which the paralysis appears and disappears by turns; a phenomenon which will not surprise us, when we have seen that in meningitis, paralysis can exist only when there is compression of the brain. Simple hyperæmia of the pia mater, slight purulent infiltration of this membrane, are capable of producing it, or, to speak more accurately, are capable of producing in the brain that modification, inappreciable after death, which gives rise to it."

Dr. Abercrombie† makes the following acute observations on a form of meningitis which I have more than once had the opportunity of observing:—

"A dangerous modification of the disease, which shows only increased vascularity.

* P. 51. † P. 61, § viii.

"Another important modification of the disease occurs in an insidious and highly dangerous affection, which, I think, has been little attended to by writers on the diseases of the brain. It is apt to be mistaken for mania, or in females for a modification of hysteria; and in this manner the dangerous nature of it has sometimes been overlooked, until it proved rapidly and unexpectedly fatal. It sometimes commences with depression of spirits, which, after a short time, passes off very suddenly, and is at once succeeded by an unusual degree of cheerfulness, rapidly followed by maniacal excitement. In other cases these preliminary stages are less remarkable; the affection, when it first excites attention, brings us its more confirmed form. This is in general distinguished by remarkable quickness of manner, rapid incessant talking, and rambling from one subject to another, with obstinate watchfulness and a small frequent pulse. Sometimes there is hallucination, or conception of persons and things which are not present, but in others this is entirely wanting. The progress of the affection is generally rapid; in some cases it passes into convulsion and coma, but in general it is fatal, by a sudden sinking of the vital powers, supervening upon the high excitement, without coma. The principal morbid appearance is a highly vascular state of the pia mater, sometimes with very slight effusion between it and the arachnoid. The disease is one of extreme danger, and does not in general admit of very active treatment. General bleeding is not borne well, and the treatment must in general be confined to topical bleeding, with purgatives, antimonials, and the powerful application of cold to the head. The affection is most common in females of a delicate, irritable habit, but also occurs in males, especially in those who have been addicted to intemperance. I have, however, seen it in one case, in a gentleman between 40 and 50, of stout make and very temperate habits. The cause of death is obscure; it seems in general to be a sudden sinking of the vital powers, supervening upon the high excitement, without any of the actual results of inflammation."

The following cases are related by Dr. Abercrombie to illustrate this class of symptoms, and the first is one of those cases which illustrate inflammation from within, excited by mental causes. The color of the hemispherical ganglion unfortunately was not noted, but the inflammation of the pia mater without that of the arachnoid is particularly described.

Case 37.—A lady, aged 23, had suffered much distress from the death of a sister, and had been affected in consequence with impaired appetite and want of sleep. This had gone on for about two months, when, on the 4th of August, 1825, she sent for Dr. Kellie, and said she wished to consult him about her stomach. He found her rambling from one subject to another with extreme rapidity and considerable incoherence; and on the 5th, she was in a state of the highest excitement, with incessant talking, alternating with screaming and singing: pulse from 80 to 90. In the evening she became suddenly calm and quiet after an opiate; continued so for an hour or more, then fell asleep, and after sleeping two hours, awoke in the same state of excitement as before. The same symptoms continued on the 6th; the pulse in the morning was little affected, but after this time it became small and very rapid. On the 7th, after a night of great and constant excitement, she had another lucid interval, but her pulse was now 150. The excitement soon returned, and continued till four in the afternoon, when she fell asleep. She awoke about eight, calm and collected, but with an evident tendency to coma; pulse 150, and small. She now took food and wine, and passed the night partly in a state of similar excitement, and partly comatose; and died about mid-day of the 8th, having continued to talk incoherently, but knowing those about her, and in general understanding what was said to her.

Inspection.—The only morbid appearance that could be discovered was a highly vascular state of the pia mater, with numerous red points in the substance of the brain.

Case 38.—A gentleman, aged 44, of a stout make, and very temperate habits, became suddenly affected, without any known cause, with extreme depression of spirits, accompanied by a good deal of talking and want of sleep. After this condition had continued for two days, it went off suddenly, and he recovered excellent spirits and talked cheerfully. This, however, was soon succeeded by a state of excitement, with rapid incoherent talking, and obstinate watchfulness, and the pulse rose rapidly to 160. This state continued without abatement for about four days, when he suddenly sank into a state of collapse, and died.

Inspection.—The only morbid appearance was a highly vascular state of the pia mater and arachnoid, with slight serous effusion betwixt them.

There is a case related by Morgagni, Epist. LXII. No. 5, something similar to the last.

Case 39.—The patient in the first instance was laboring under a false impression, which, producing excessive fear, was followed by tremors, convulsions, pain in the head, and loss of speech, but not of consciousness. He died seven days after the appearance of the first symptoms, and the morbid appearance discovered after death was merely congestion of the pia mater.

Although headache is the usual concomitant of meningitis, still there are cases in which this symptom is absent. Out of twenty-eight cases reported by Andral,* there were sixteen in which the headache existed, and twelve in which this symptom was not observed; but in these twelve there was one case in which the patient was not minutely watched, and another in which the delirium having existed from the commencement, the pain of the head could not be complained of by the patient.

In the sixteen cases in which the pain did exist, the alterations discovered after death were as follows:—In two of these cases the patients presented tumors developed primarily in the dura mater, which had compressed the nervous substance in contact with them. In two other cases an effusion of blood existed in the great cavity of the arachnoid.

In two subjects, no other alteration was observable but considerable effusion of liquid serum into the cerebral ventricles. Three other subjects presented nothing but redness of the meninges. Another case presented pseudo-membranous concretions deposited within the great arachnoid cavity.

In five *post-mortem* examinations the pia mater was found, whether of the convexity or of the base, infiltrated with pus. In one of these five there were also found cellular adhesions intimately connecting together the two reflections of the arachnoid covering the convexity of the brain. This individual had been all his life tormented with headache.

In only one case were the ventricles found filled with purulent fluid. "From these facts," says Andral, "we are warranted in concluding that the pain accompanying diseases of the meningis may exist with diseases of these membranes, widely differing from each other both in their nature and their seat.

"Let us now inquire what lesions were found in the membranes in the twelve patients who complained not of headache. In two of them the pia mater was infiltrated with pus, either the portion of it extended over the convexity of the cerebral hemispheres, or that covering the base of the brain. A sero-purulent liquid filled the ventricles in one case.

"From these facts it follows that the diseases of the membranes,

* P. 47.

during which no headache was observed, differed neither in their nature nor in their seat from those in which pain of the head was one of the symptoms." Andral goes into the details of this subject with great care, and his facts are worthy of attention.

"It has not been found," he says, "that the different degrees of the intensity of the headache depended either on the nature of the lesions of the membranes, or on their seat. We have found it as acute in cases where there was but simple injection of the pia mater, as in those where the pia mater was infiltrated with pus, or where a false membrane covered the arachnoid. With respect to the seat of the lesions, we find that, in cases where the headache was most intense, some related to meningitis of the convexity of the hemispheres; others to meningitis of the base of those hemispheres; others to inflammation of the entire membranes surrounding the nervous centres; others, again, to effusions of pus or serum into the ventricles.

"Between these cases and those where the pain of head was either much weaker, or none at all, we do not find any difference with respect to the lesions; and in order to explain so many varieties, we are always obliged to admit individual dispositions, which, with lesions apparently identical, produce, according to the subjects affected, phenomena of the most different kind.

"The nature, also, of the pain felt by patients attacked with meningitis is not the same in all. Some think that there is an enormous weight on their skull; some complain of violent lancinating pain either continued or returning at intervals; several fancy that a tight band compresses their forehead; some say that their head is squeezed, as it were, in a vice. All motion applied to the head, or even to the other parts of the body, is oftentimes intolerable. We have seen some patients whose headache was increased by slight pressure made on the integuments of the cranium. We never saw, on the contrary, this pressure diminish the headache, as so often happens in the cases of headache called nervous. The period when the headache appears is not the same in all cases. Most frequently, however, it shows itself from the commencement, sometimes dull at first, and gradually becoming intense; sometimes, on the contrary, attaining at once its maximum of severity. In several cases of our own, in very many published by MM. Parent and Martinet, and in nearly all those of M. Dance, the pain of head showed itself from the very commencement. The cases in which headache marks the commencement of the disease seem divisible into two series, according as the headache develops itself singly, without any other morbid phenomenon accompanying it, or according as its appearance coincides with that of other symptoms. The first series includes the most numerous cases. The time during which the headache continues, the only appreciable morbid phenomenon may vary from some hours to several days. When this headache thus precedes the other symptoms, there are some cases in which it seems to have nothing serious in it. It sometimes resembles mere rheumatic pain; sometimes it might be taken for neuralgia. There are some individuals who for some time seemed to have merely a megrim more or less violent; the mistake was easily fallen into in those cases, where, a little after the appearance of the headache, vomiting

supervened. The second series includes those cases in which the headache still presenting itself at the commencement, is accompanied, from the moment of its appearance, by other symptoms, whether of mere febrile commotion, or of different disturbances of innervation. There are some rare cases in which the pain of head continues with great intensity during the entire disease; but most frequently there are developed on the part of the nervous system more severe symptoms, which soon prevent it from being perceived or complained of by the patient. It may then be laid down that the pain of head generally exists only during the first period of meningitis. It is very uncommon to see it come on after this period. Headache is almost the only modification of sensibility observed in the ordinary cases of meningitis. In some few of the cases reported by us, the cutaneous sensibility was rendered rather obtuse; but it may be remarked, that in one of them the brain itself was the seat of considerable pressure, made by a tumor developed in the dura mater. There was one case also where the sensibility was very much exalted. From several cases published by M. Parent and also by M. Dance, we feel warranted in laying it down, that in the meningitis of adults, modifications observed in the cutaneous sensibility may be considered as mere exceptions; when they do exist, they are to be referred to a peculiar disposition in the subject, and not to any specific lesion."

The great practical point, as it appears to me, with regard to the information derivable from the existence of pain in the head, its peculiar character, seat, and duration, in the diagnosis of cerebral disease, is this—that pain *alone* cannot be regarded as affording any instruction, but that when it is weighed in the balance, with other signs significant of disease of the nervous system, then the character and seat of the pain become important.

For instance, if the patient has violent pain in the head, but the temper and mind are not unusually disturbed and excited, and there is no indication of incipient paralysis or irritability of the muscular system, no insomnolence except such as would be occasioned by severe pain in any part of the body, then is the pain no indication of cerebral disease. But if, with such symptoms as above described, the patient complains of pain in the head, then is its existence a most important sign of inflammatory mischief, requiring more or less local depletion and derivation of the blood to other organs; the intestinal canal with its extended surface always affording an open field for rapid evacuation of the nutritive fluids.

The whole subject of headache is one of great interest, but regarding its pathology we have still much to learn. Dr. Bright* observes—"That this symptom depends on various causes, and that it is connected with different conditions of the circulation in the brain, is not improbable; but in by far the majority of cases the actual condition of the vessels at the moment of the existence of headache is a state of congestion. Exhaustion from fatigue, exhaustion from the loss of blood, exhaustion from over excitement by mental exertion or bodily excesses, all tend to produce a state of debility in the vessels of the brain which favors con-

* Op. cit., p. 222.

gestion; and these are the more ordinary circumstances, under which headache occurs. The headache which follows apoplectic and epileptic attacks, that which torments the hysteric female, and that which so often attends on the dyspeptic stomach, all probably depend on cerebral congestion variously modified and combined, according to the causes which give rise to it, or to the peculiar state of the constitution in which it occurs."

I am acquainted with a gentleman who suffers occasionally from dyspeptic headache; and indiscretion in diet will bring it on, especially if he has been at all worried in business and much confined in London. But his headaches are always hemicranial, confined entirely to one side of the head. And they alternate regularly; for instance, if he has a pain on the right side one week, and the pain has entirely disappeared, the next time it will be strictly confined to the left side. Sometimes the pain is so severe as to keep him awake at night, and if he falls asleep it will awake him. A slight mercurial purgative will always remove it when very severe; cold applications relieve it, all motion aggravates it, and the contact of the foot with the ground jars the head; it does not affect the mind even at the time of its duration, and leaves no ill effects afterwards. Does this depend on local congestion? I can scarcely believe so. Nor do I see any reason for attributing it to anæmia.

From these cases, which seem to illustrate the effect of inflammation on the instruments of volition and the organs of intellect, let us next turn to the consideration of *inflammation of the substance of the hemispheres—the tubular neurine;* the following cases certainly demonstrate that the sensibility may be exalted first, and impaired afterwards, as well as that muscular contraction may be excited first, and destroyed afterwards, without the intellect being affected, when the inflammation is confined to that portion of the cerebral substance which is *within* the gray matter of the convolutions, that matter remaining itself unaffected. The important conclusions which may be drawn from these facts, regarding the office of these two portions of the brain, are equally interesting to the physiologist and the practitioner.

I believe that inflammation of the substance of the hemispheres, or rather, it should be said, of the tubular portion, is characterized by the appearance of convulsions previous to any sign of mental excitement. This inflammation frequently terminates very rapidly in ramollissement.

This form is extremely insidious; the absence of any disturbance of the intellectual faculties prevents the attention of the patient and the friends being called to the ailment as serious in its nature.

The headache which accompanies it is generally slight, but still if the patient is intelligent, and can describe the pain he suffers, he will say that it is different from any he ever felt before, that it is not severe pain, but that it is a *most* uncomfortable feeling. There is another symptom of a most serious import, and one which should never be neglected—it is vomiting.

The convulsions are occasionally followed by coma and then all doubt regarding the danger of the attack is at rest: though it is true, as stated by Dr. Abercrombie, that sometimes after the coma has lasted for a certain time, perhaps for twelve hours, there is a complete recovery from

it, and for several days the patient appears to be in a favorable state; when, without any warning, the convulsion returns, and terminates in fatal coma. If there is one thing more inexplicable than any other in cerebral diseases, it is their cessation and remission, sometimes amounting to an almost regular periodical intermittent. But still the effect of quinine in such cases is, like other stimulants, deleterious.

In the early stage of this complaint the pupil may not be affected, but, generally speaking, if the case is carefully and constantly watched, one pupil, if the disease is very limited (and it is quite extraordinary how isolated and limited the seat of inflammation frequently is) will be found first contracted and afterwards dilated. Injuries of the head have been already cited as among the causes which produce inflammation of the hemispherical ganglion, and thus affect the intellect; we must again refer to them in relation to the tubular substance beneath, and the effect on the conducting instruments of the brain, as shown by involuntary convulsive actions of the muscles. When an injury to the head is immediately followed by convulsions, it is generally a sign of very serious and severe injury to the substance of the brain, usually a laceration.

When convulsions, after a few days, supervene on a blow of the head, they must be promptly attended to, as indicative of inflammatory mischief in the tubular structure or under surface of the ganglion. The following case illustrates this subject well:—

Case 40.—Thomas Smith, aged 14, was admitted from Woolwich into George's Ward, St. Thomas's Hospital, under Mr. Solly, as Mr. Green's assistant, May 11th, 1846, stated to have fallen from a scaffold about twenty feet high, pitching upon his head. When picked up he was found quite insensible, and bleeding from the right ear. The accident occurred at 7 A. M., when he was sent to the hospital, and seen by Mr. Solly at half-past 9 A. M. He had been insensible up to the time of admission, and continued so at that time. His head was shaved, and cold lotion applied; at half-past 1 P. M. he had recovered his senses; his pulse was somewhat slow and laboring; pupils dilated, particularly the left, but contracting upon the admission of light; he complained of pain in the head, and was very drowsy.

At 9 P. M. was much the same as in the middle of the day.

Treatment.—9 A. M., Hydr. Chlor. gr. v. stat. sumend.

2 P. M.—℞. Hydr. Chlor. gr. ij. quâque 2dâ hora sumenda. Hirud, xx. ad caput applicand.

9 P. M.—Venesectio ad ℥xij.

May 12th, 8½ A. M.—Complains still of pain in the head; continues drowsy; pulse 72; bowels not opened, although he has taken eight doses of calomel.

8½ A. M.—Hirud. xxx. Hydr. Chlor. gr. v. quâque hora donec alvus soluta sit.

1 P. M.—Pergat.

11 P. M.—Enema—statim, repr donec alvus soluta sit.—Sleeping; sensible when roused, but complains of his head, more particularly the left side. Bowels not yet open; has taken nine 5-grain doses of calomel: the calomel to be omitted till morning.

May 13th.—Sleeping; not easily roused, but quite sensible when awake; answers—I have got the headache, sir—then dozes off again. Pulse 64. Bowels opened twice by the enema; stools lumpy and dark brown. Hydr. Submur. gr. v. mane primo.

1 P. M.—Rather more drowsy; becoming forgetful. Hirudines xxx. applicantur.

7 P. M.—The sister observed that he had slight grating of the teeth, and almost immediately afterwards thrust his tongue from his mouth, which remained out; the right arm was at the same time drawn up, and there was working of the eyes. The sister thought he was conscious, but he could not speak; she then sent off immediately for Mr. Solly.

8 P. M.—Countenance more anxious; not so easily roused; answers less readily; speaks in a more drawling way; pulse 76, not so full. Mr. Solly opened a vein in the arm, but the blood, which was very dark, flowed so slowly that he opened the temporal artery; the patient was raised from the pillow, and as soon as a little more than an ounce of blood had flown, he had a convulsive fit, it was slight, and accompanied by a low moan. The artery was then divided, and he laid again on the pillow, the bleeding being stopped. He almost immediately recovered his consciousness, his countenance was pale, and his surface covered with a cool sweat. Pulse 56, irregular. After a few minutes he seemed a little

more conscious, and said, in answer to a question, that he was easier. ℞. Hydr. c. Cretâ gr. ij. 4tis. horis.

May 14th.—Says he is very bad, but seems more conscious; has had no more convulsions; says that his head aches. Pulse 72, soft; mouth a little tender.

9 P. M.—Countenance better; more cheerful; head cooler; pulse 80; *pergat;* says he is a little better.

About 11 P. M., he had a convulsive fit, very short, mouth drawn to the right side, foamed at the mouth, did not scream; a few minutes before, he had started up in bed, and would have fallen out but for his attendant; he had several such fits during the night.

May 15th, 8½ A. M.—Countenance very heavy and dull, scarcely answers any questions; right side of face slightly paralyzed, also the right arm; can feel when pinched, but not readily; bowels not open; *pergat.*

7½ P. M.—Has had seven or eight fits during the day, not of great length or severe. Countenance much the same; answers questions slowly, but rationally; bowels relieved this afternoon; motions loose and green; pulse 80; *pergat.* Acet. Lyttæ, pectori. Ungt. Hydr. to the blistered surface.

May 16th.—Pulse 80: not so conscious, or well in other respects.

May 17th.—Very drowsy, little conscious; has frequent fits: countenance bad; pulse 140; cannot get him to take any food.

May 18th.—Much worse; countenance anxious; can scarcely answer any questions; says he wants his breakfast; always expressing a feeling of hunger. Pulse 150, small. Has convulsions every ten minutes.

May 19.—Countenance worse, and more anxious; says that he is better, and the pains in the head less, but has greater difficulty in speaking. *Pergat.*

May 20th.—Countenance much the same; says he is a little better, but does not appear so; pupils act to light; right arm paralyzed, but not the leg. Convulsions continue. *Pergat.*

May 21.—Convulsions not so frequent in occurrence, but continue for a greater length of time, and are more violent; he is not so drowsy, his countenance is improved, and he is perfectly conscious; says he has less pain in his head; pulse 130; bowels open; tongue cleaner.—*Continue treatment.*

May 22d.—The convulsions continue very violent, but occur less frequently than yesterday; still pain in the head; pupils contract to light; pulse 120; bowels open; says he feels better.

May 23d.—Little alteration as regards the frequency and violence of the convulsions; has the power of moving his right arm, which was paralyzed on Wednesday, and can close his hand; countenance much improved; pulse 120; bowels open.—*Continue treatment.*

May 24.—Has had no fit since last night; almost entirely recovered the use of his right arm, and appears much relieved, the pain in the head being less severe; countenance good; tongue cleaning; bowels open; pulse 112; complains of his gums being tender.—*Continue treatment.* Lotio frigida ad caput applicanda.

May 25th.—Continues free from fits; has quite recovered the power in his right arm. Pulse 108; bowels open: appetite improved. Cont. Pilulæ nocte maneque. Omitt. Ungti. applicatio.

May 26th.—Has passed a very good night; no recurrence of the fits; pain in the head slight, and confined to the frontal region; bowels open; pulse 108.

May 27th.—Says he is better; has but little pain in the head; countenance good; tongue cleaner; pulse 112; bowels confined. Ordered by Mr. Solly to take Compd. Colocynth pill ten grains, to be repeated, if necessary; he had a relief shortly afterwards, consequently the aperient was not administered.

May 28th.—Is progressing favorably.

June 3d.—His gums being still tender, and he generally much improved, to take the mercury less frequently. ℞. Hydr. c. Cretâ (gr. ij.) alt. noct.

June 7th.—Is much better; says he has no pain in the head or elsewhere; bowels open; tongue clean; appetite good; pulse 90.

June 13th.—Appears and describes himself as feeling quite well, and is rapidly gaining strength. The use of the mercury to be discontinued.

Presented, June 29th, quite well.

I believe that the pathological course of this case was thus: first, concussion of the brain, with either slight fracture or displacement of bones at the base of the skull, as indicated by the bleeding at the right ear; serious injury to the right side of the brain, indicated by dilatation of the left pupil, taken in connection with the bleeding from the right ear. The injury of the brain confined to the base, indicated by the ab-

sence of much intellectual disturbance; effusion of blood into the tubular structure not in sufficient quantity to produce immediate paralysis, but sufficient to irritate and excite inflammation, indicated by the spasmodic action and convulsions; effusion of lymph consequent on the inflammation indicated by the paralysis; arrest of inflammation by bloodletting and mercury; absorption of lymph by continued action of mercury, restoration of the injured brain—recovery.

I never examined after death a case in which inflammation was limited to the tubular portion of the hemispheres. In those cases on record where this occurred, the disease was ushered in with headache, then convulsions, soon followed by paralysis: if the disease extends upwards and outwards to the hemispherical ganglion, then the mental faculties will be more or less excited and perturbed; if downwards to the ventricles, then, effusion taking place, coma is the consequence.

The following case (and I think it supports my view of its pathology) is in point after the last; I shall designate it acute stimulation of the motor tract, as well as the hemispherical ganglion. It is from Andral.*

Case 41.—*Acute meningitis limited to the convexity of the left hemisphere of the brain; delirium; convulsive movements of the face and extremities of the right side.*—A tailor, 37 years of age, had been sick four or five days when he entered the hospital, 17th July, 1821. On the 15th of this month, without any known cause, he was seized with violent pain of the head, particularly seated in the frontal region. On the day after, the headache continued, and the pain became more general, being extended now to the parietal and occipital regions. On this day he lost his appetite, and vomited some drink he had taken. In the evening constant nauseau still appeared, followed from time to time by a throwing-up of some bitter yellow matter.

On the 17th the headache continued, but the vomiting ceased; some nausea still. Having entered the hospital, he presented, on the next day's visit, the following state:—face remarkably pale; pain of head, the precise seat of which cannot be pointed out by the patient; at intervals this becomes so very severe as to make him utter piercing cries; eyes dim and languid; slight involuntary motion of the muscles which move the commissure of the lips; his answers accurate; gives a perfect account of his state, and of everything which happened to him since the commencement of his illness; the pulse moderately frequent and regular; everything else natural.

It was difficult to assign a precise seat to this group of symptoms; the first complaints, however, regarded the head; the vomiting might be considered as connected with a commencing cerebral affection, and the severe headache seemed to point out the head as the seat of disease. The absence of any morbid phenomenon with respect to the alimentary canal, repelled the idea that the headache was sympathetic of gastro-intestinal irritation. The absence of all febrile disturbance precluded the possibility of its being mere continued fever. The state of the patient, however, appeared very alarming; the appearance of his countenance, and, amidst the absence of local symptoms, the great alteration already of his features, obliged us to form a rather unfavorable prognosis. M. Lerminier suspecting a state of encephalic congestion, applied, notwithstanding the extreme paleness of his face, twenty leeches across each jugular vein. Demulcent drinks, and sinapisms to the lower extremities. No change in the patient on the following morning.

On the 20th he was very much cast down, and answered questions with difficulty and reluctance; light was painful to him; he kept his eyes closed and his head concealed under the bedclothes; face very pale; pain of head not great; the convulsive movements of the lips more frequent and more marked; pulse and skin natural. (Blister to the nape of the neck.) In the night he emerged from a state of stupor, in which he had been for the last twelve hours. He got up out of bed suddenly, saying that some persons were pursuing him to do him harm. He raved during the night, and occasionally uttered several piercing cries.

On the 21st he was kept in bed by force. The face had now become red; the head was agitated by a continual movement, which carried it from right to left, and left to right; the muscles moving the lips, the alæ nasi, and the eyebrows, were in the highest degree of con-

* Case VI., p. 6, op. cit.

vulsive agitation; saliva, slightly frothy, flowed in great abundance from the mouth; he spoke incessantly and with energy, but his articulation was unintelligible; great subsultus tendinum, which prevented the pulse from being felt; its frequency did not seem very great. (Bleeding from the arm, twenty leeches to the neck, cold applications to the head.) No change on the 21st.

On the 22d, violent delirium; convulsive motions of the muscles of the face; risus sardonicus; continued motion of the right arm; subsultus increased; pulse more frequent; tongue moist and red. (Two blisters to the thighs; ice to the head.)

On the 23d, head turned back, and to the right; strong contraction of the right arm; respiration very irregular; occasionally accelerated; it then becomes slower than natural. The patient silent and quite still; eyes fixed, and void of expression; mouth open and unmoved; pupils neither contracted nor dilated; answers no questions; does not even seem to understand them; original paleness of face returned; pulse sixty a minute, and regular; bowels not free; tongue cannot be seen; teeth not dry. He remained quite torpid during the day, but at night violent delirium re-appeared; uttered very loud cries.

On the 24th, this excitement was succeeded by profound coma; extremities cold; a clammy sweat covered the face; respiration *ralaut.* Died in the course of the day.

Sectio cadav.—On the upper surface a considerable difference in the color of the two cerebral hemispheres, the right being pale, while the left presented a well-marked red tint, which resided entirely in the sub-arachnoid cellular tissue, which was traversed by numerous vessels; neither serum nor pus in the tissue; the gray substance, constituting the most superficial portion of the convolutions of the left hemisphere, participates in the injection of the pia mater covering it. The ventricles contained scarcely two spoonsful (*cuilleries à café*) of serum; nothing remarkable in the rest of the brain The lungs infarcted posteriorly; the heart contained in its right cavity a large fibrinous clot, deprived of its coloring matter; the mucous membrane of the stomach very thin towards its great cul-de sac.

Case 42.—*Softening of the right cerebral hemisphere; acute pains in the left extremities, which subsequently became paralyzed, still continuing painful.**—A woman, 71 years old, had felt, for about a year before entering the hospital, acute pains in the two extremities of the left side. These, which were at first transient, became lancinating, occupying particularly the anterior surface of the upper extremity, and the posterior surface of the lower extremity.

When they were intense, they gave rise occasionally to slight convulsive twitches of the fingers, and particularly of the index finger; occasionally, too, but only after or during a pain, the thumb was flexed on the palm of the hand, the flexion never lasting beyond ten or twelve minutes. This was the first time the patient experienced such pains; by degrees they became more frequent, and at last continued; but at the same time, they abated of their original severity, and ultimately the patient only felt in the extremities of the left side, and particularly in the upper, a sensation of formication. She continued thus for five months; she then ceased to be able to sustain herself on her left leg as well as before; this limb seemed to her dull and heavy, and she dragged it a little in walking. At this time also the left upper extremity became weaker; she could no longer grasp or hold any weighty object with the hand of this side. By degrees this paralysis increased, and at the end of six weeks it was as complete as possible. But, what was extraordinary, from the time the muscles of the extremities of the left side were entirely deprived of voluntary motion, the pains which had marked the commencement of the disease returned with their original severity; and from time to time they increased so as to make her shed tears. This was the state she was in when she was submitted to our inspection. She was at this time emaciated and pale, eyes sunk, features drawn, and expressive of long suffering. Every two or three days the extremities were, as it were, furrowed by acute pains. The skin of these parts much more insensible than those of the limbs of the right side. Power of motion completely destroyed in them; right commissure of lips drawn up; tongue deviated sensibly to the left; skin of face on right side less sensible than on left; the intelligence perfect. She told us, that from her nineteenth to her twenty-third year she had been tormented with violent beating of the heart, accompanied with great difficulty of breathing. These symptoms, however, completely disappeared. After remaining about a month in the hospital, a large eschar formed on the sacrum: she gradually wasted away; her feet became œdematous, and she sank exhausted, retaining her intellect to the last.

Sectio cadav.—On a level with and external to the optic thalamus and corpus striatum of the right side, we found considerable softening of the cerebral substance, which extended to the base of the brain. Anteriorly it was limited by a line, the internal extremity of which might terminate at the junction of the anterior four-fifths with the posterior fifth of the corpus striatum. Posteriorly it extended nearly to the posterior extremity of the hemisphere. No injection in the softened portion. The softened cerebral substance is of a grayish white

* Andral, op. cit., Case XV., p. 145.

in certain points, and yellowish in others. The fornix and septum lucidum diffluent. The two lateral ventricles distended with serum. The great arteries of the brain ossified. Heart and lungs healthy; some ossifications in the aortic valves. The gastric mucous membrane visibly softened towards the great cul-de-sac in several points.

The lining membrane of the ventricles is sometimes inflamed without the arachnoid on the surface being affected. Andral remarked that diseases of the former are not necessarily connected with diseases of the pia mater surrounding the brain, either at its base or convexity.

When the lining membrane of the ventricles is inflamed, without the hemispherical ganglion having been previously attacked, as is usually the case, the symptoms are peculiar; for the arachnoid and pia mater of the surface are most frequently attacked in the first instance, and that of the ventricles subsequently. The diagnosis might perhaps be considered more interesting in a physiological than useful in a practical point of view. But such is not the case, for this form of inflammation is so insidious, and its formidable character so liable to be passed over until it is too late to apply our remedies, that we cannot be too much alive to the symptoms which indicate its presence. The following case illustrates this. When I related it to a medical society, some very sound and careful practitioners remarked on its close resemblance to many cases of hysteria which were occurring daily in their practice.

Case 43.—In the summer of 1844, at 2 P.M., I visited in consultation a young lady, æt. 15, suffering in the following manner:—I found her lying on a sofa, her countenance much flushed, her head hot, pulse irregular and quick, but without much power; strabismus of the right eye towards the nose, both eyes bright and rather staring. She was not able to answer any questions, but sufficiently conscious to open her mouth slightly, and partially protrude her tongue, the tip of which was brown and dry; her right arm was raised in the air and jerked about spasmodically; afterwards she picked the bedclothes, but she was unable to move the limbs on the left side at all.

The gentleman in attendance informed me that he had seen her occasionally for some time past, with various symptoms; at one time with a cough, very similar to hooping-cough; and on more than one occasion suffering from severe affection of the respiratory organs, and the next quite well: she was also subject to many hysterical symptoms. She first menstruated one year back; but she has since been irregular, three months having elapsed without any show.

For the present illness Mr. F. visited her six days ago; he found her with an exceedingly quick, small pulse, without anything apparently to account for it; there was a general dullness of expression; eyes looking heavy; pupils dilated; intellect rather blunted, giving perfectly correct answers, only very slowly. She complained of pain in the left side of the abdomen, and slight pain in the head. He ordered her saline aperients and hyoscyamus in very small doses.

Mr. F. informs me that no very decided change took place in her symptoms till the fourth day, when she was much worse; she complained of cold chills, and soon after the parents observed that the limbs on the left side lay like withered limbs, and those on the right side were seized with convulsive movements. She was still sufficiently sensible to complain of the jerking of her limbs, which she said were mad. Her intellect became gradually more dull, but she was not delirious.

I told Mr. F. that I considered that there was inflammation of the lining membrane of the ventricles, with effusion, and I was afraid that there was some softening about the thalamus, more especially on the left side. She died about eight hours after I saw her.

Post-mortem, 84 hours.—*Body* plump, slightly green over the abdomen, but otherwise fresh.

Head—Convolutions of the upper part of the brain flattened; no inflammation of the arachnoid in this situation, or sub-arachnoidal effusion; slight softening of the great transverse commissure; ventricles filled, and distended with bloody serum mixed with some pus. The lining membrane of the right ventricle slightly inflamed, studded all over with ecchymosed spots; sero-sanguineous effusion into the left ventricle; suppuration, with softening of the right thalamus, some softening of the left, some effusion at the base round the medulla oblongata.

Abdomen.—Hydatid attached to each broad ligament of the uterus.

It is sometimes difficult to decide whether the quantity of fluid contained in the ventricles, is above the normal quantity, whether it is in morbid excess. If the arachnoid and pia mater are torn either at the base of the brain, so as to open the inferior cornu of the lateral ventricles, or at the foramen of Bichat, or at the fourth ventricle, then the fluid escapes before these cavities are opened. If this fluid is greatly in excess, the form of the convolutions and fossæ digitatæ at the vertex of the brain indicates the fact; the convolutions are flattened, and the sides of the fossæ in close contact. If we suspect an abnormal quantity of fluid, it is important to mark their condition before opening the ventricles.

Andral considers that the presence of serum in the ventricles should only be considered the result of a morbid process when its quantity exceeds an ounce in each lateral ventricle. Excess of serum is more frequently met with in the ventricles than in the external arachnoidal sac.

Andral remarks, that when the quantity is very considerable, the septum lucidum and fornix are always found softened.

It is difficult to say whether this softening is the result of the same inflammatory action which gives rise to the effusion, or whether it is a mere physical effect from imbibition, as stated by Dr. Hughes Bennett. I have no doubt that it is sometimes one and sometimes the other, but most frequently the effect of inflammation, and as such to be considered.

Inflammation of the corpus striatum does occur sometimes, though seldom without some other portion of the brain being involved. Dr. Abercrombie relates a case in which there was a small abscess in both corpora striata, the rest of the brain being perfectly healthy.

In drunkards, and persons of excitable dispositions, who are much harassed with the cares of life, I believe that the brain is liable to be frequently congested, and that the blood-vessels become permanently enlarged.

M. Max. Durand Fardel* has well pointed out the change which takes place in these cases. He calls it a sieve-like condition of the brain, *état criblé du cerveau.* "These little holes are usually surrounded by perfectly healthy cerebral substance. They are circular, with well-defined edges, scattered irregularly through the brain, varying in diameter, and unchanged in form by a stream of water. If water is allowed to flow on them for any time, the cerebral substance is gradually washed away, and the little holes are seen to have been the artificial openings of canals, each of which contained a vessel."

"The sieve-like condition of the brain is sometimes found unassociated with any other lesion; at other times, however, it co-exists with the various forms of softening of the brain, and especially with the general *ramollissement* of the cortical layer of the convolutions which M. Calmeil has described as peculiar to the general paralysis of the insane, with induration of the brain, &c. Evidence exists to prove that the connection between the *état criblé* of the brain and other lesions with which it is associated is not merely accidental; thus, in one instance, in which idiotcy, attended with occasional attacks of mania, followed a

* Gazette Médicale, Jan. 15th, 1842, quoted in the British and Foreign Quarterly Medical Review, vol. xiv. p. 225.

blow on the head, induration of the brain, and the *sieve-like condition*, were found confined to that hemisphere of the cerebrum on which the injury had been inflicted. It is not unusual in cases of chronic softening of the brain to meet with this sieve-like appearance for some distance around the softened part, betokening the previous existence of dilatation of the vessels. In the same brain, too, M. Fardel has met with recent *ramollissement* and injection of the vessels, and old *ramollissement* with the *état criblé*."

From his observations, many of which are detailed at length, the writer concludes that "the [*état*] *criblé* of the brain is produced by the presence of a great number of small canals, perforated in the cerebral tissue, each containing a little vessel, to the dilatation of which their formation is doubtless owing. These canals, the existence of which is normal in some parts of the brain, appear in a rudimentary state, without being necessarily morbid, in some persons in advanced life.

"The usual seat is in the cerebral hemispheres, especially beneath the convolutions, but they are likewise met with in the cerebral protuberance, and in the medulla oblongata.

"Though somewhat different in appearance, the little cavities so often seen in the corpora striata are probably of a similar nature.

"The general or partial dilatation of a great number of the vessels of the brain appears to be owing to chronic sanguineous congestion, or to frequent recurrence of congestion of the organ.

"This opinion seems sufficiently warranted by the phenomena observed during life, as well as by the alterations which are found after death to co-exist with the *état criblé* of the brain.

"Twice this condition existed uncombined with any other appreciable lesion of the brain. In one of these cases there was simple dementia, in the other, dementia with general paralysis.

"It is found associated with superficial *ramollissement* of the convolutions in insane persons affected with general paralysis, with general or partial induration of the brain, and in the centre of, or around, portions of softened brain.

"This state probably existed, but escaped notice in cases where grave cerebral symptoms were not found to have given rise to any lesion appreciable after death."

In considering the effects of inflammation on the cerebral substance, we must not omit induration. We have already turned our attention to softening, both as the result of anæmia and hyperæmia, and it may seem strange that the same action of the capillary system should produce a totally opposite condition.

Induration of the Brain.—The existence of such an alteration in texture is now acknowledged by all pathologists, and I believe it is generally admitted to be the result of hyperæmia of the part. It may seem strange that inflammatory action should produce both softening and hardening, but such seems really to be the case. The induration accompanying hypertrophy has been already adverted to. It is to the more partial induration that we must now direct our attention. Andral*

* Pathological Anatomy, p. 75.

mentions several instances. "Induration," says this author, "of the centre of the medullary substance of the cerebral hemispheres was observed by M. Pinel, in a woman who died in a state of insanity; the posterior and inferior margin of the cerebellum was also so indurated as to become almost fibro-cartilaginous. M. Payen once found in a child, six years old, a depression in the posterior third of the left cerebral hemisphere, which was owing to the induration and shrinking of one of the convolutions. The superjacent membranes, which were thickened and white, accurately defined the extent of the diseased part. The girl, who was of a melancholy temperament, but remarkably intelligent, had from her birth a contraction of the right wrist and foot, together with slight atrophy and incomplete hemiplegia of the same side."

Induration has been supposed by some to be a stage of inflammatory action, antecedent to that which produces softening, and seems very probable; but it must be considered of a slower and less acute character. This is Dr. Copland's opinion, and quite accords with my own limited observation.

The fact of its being so often found in the brain of lunatics is interesting and important, as throwing further light on the pathology of that disease, and pointing to the proper mode of treating it medically. "*General induration* of the brain," says Dr. Copland,* "generally occasions loss of memory, confusion of thought, and derangement of the mental manifestations, causing insanity without lucid intervals. When the induration is advanced in degree, or considerable as to its extent, or both, and especially when its long duration has been indicated by continued mental derangement, a complete obliteration of the mental faculties, or fatuity, is frequently its attendant towards the last periods of life, and may, therefore, be considered as the consequence of the most advanced degrees of this lesion. The signs of *partial induration* of the brain will vary according to the extent and seat of the lesion. They consist chiefly of a progressive defect of memory, inattention, or an inability to pursue a long train of ideas, indifference to momentary impressions, and to present or future occurrences, difficulty of articulation, derangement of ideas, with partial and total loss of the affections, appetites, and desires, and, ultimately, increased loss of speech, palsy, convulsions, or want of power over the muscles, fatuity, general or partial wasting, and death."

In connection with hyperæmic disease of the brain, the practitioner must remember that the scalp is liable to various eruptive diseases; but he must not set to work and heal them by local remedies, like diseases of the skin in other parts of the body, without first ascertaining how far they may have been set up by nature as a safety-valve to the brain. In children, how often do we see eczema spring forth on the head during the irritative fever of dentition, with the very greatest advantage to the child; and woe to the poor infant if the eruption is suddenly checked! It ought to be regarded as a kind adviser, telling us what may be going on within. It is surprising how soon it disappears if we lance the gums freely, and give a grain or two of gray powder

* P. 221, op. cit.

every other night, with a little magnesia and rhubarb every morning. Scarcely a week passes that I do not see two or three such cases at the General Dispensary, and I always watch them with interest for the brain's sake.

Meningitis has been described by some authors as being occasionally epidemic. It is possible as a form of fever; but in most cases I think that it will be found there is some common moral cause which produces it, rather than an atmospheric one. In the British and Foreign Quarterly Medical Review for July, 1844, there is an account, extracted from the Mémoires de l'Acad. Roy. de Méd., Paris, 1843, of this form of disease.

It appears to have ravaged the garrisons of Versailles, Lyons, Bayonne, Groet, Metz, Strasburg, &c., and its not being confined to the military gives it a title to be considered epidemic. The predisposing causes were, extreme youth of the soldier, his having recently joined the service, and being unaccustomed to military exercise. Prolonged exposure to the sun, with or without subsequent chill, but, above all, violent exercise followed by chill, appear to have acted most frequently as immediate causes. *Post-mortem* examinations detected injection of the membranes, with effusion of red-colored serosity, pus in the pia mater, softening of the medullary substance of both brain and spinal cord. The treatment recommended for simple meningitis is essentially antiphlogistic, accompanied with derivatives to the extremities, purgatives, cold applications to the head, &c.: when the cases were treated on the onset of the attack, this plan answered: but when the inflammation had extended to the substance of the encephalon, then collapse was so sudden and complete that depletion could not be resorted to until reaction had taken place. In most of these cases, M. Rollett, finding that the ordinary modes of exciting such action by blisters, sinapisms, and ammoniacal ointment, fail, tried the actual cautery to the spine, and, at the same time, sinapisms to the feet, vesications to the thigh, cupping to the neck, and purgative enemata. The cauterization gave no pain, but reaction took place in an hour or two afterwards, and then blood-letting was employed. This severe treatment was found much more successful than the older and more usual course in such cases.

In the *treatment of inflammation of the brain*, whatever the form may be, no time must be lost; minutes are even of importance. Bleeding, both topical and general, are important remedies, but they require great judgment in their application; as a general rule, venæsectio brachii is not so useful as bleeding by leeches from the head. But in cases where there is evidence of there having been good constitutional power previous to the attack, for during the attack the pulse is very deceptive, and the head is hot, and the face flushed, and the disease is progressing rapidly, then general blood-letting is indicated.

The following cases, related by Abercrombie, illustrate the value of general blood-letting. The third case shows that we must not be discouraged in the employment of this remedy, if we have deliberately decided that it is right to employ it, though it does not immediately produce a beneficial effect.

Case 44.—A girl, aged 11, had violent headache and vomiting, with great obstinacy of the bowels, and these symptoms were followed by dilated pupil, and a degree of stupor bordering upon perfect coma; pulse 130. She had been ill five or six days; purgatives, blisters, and mercury to salivation, had been employed without benefit. One bleeding from the arm gave an immediate turn to this case; the headache was relieved, the pulse came down; the vomiting ceased; the bowels were freely acted upon by the medicines which they had formerly resisted, and in a few days she was quite well.

Case 45.—A slender and delicate girl, aged 11, had scarlatina in a favorable form, in the beginning of April, 1820. About the 16th she was so much recovered as to be allowed to go about the house. A few days after this, she was affected with anasarca, for which she took some medicine, with partial benefit. About the 26th, however, the anasarca had again increased considerably, especially in the face, which was very much swelled. In the following night she had vomiting. On the 27th, she complained of headache, which increased rapidly in violence; towards the afternoon, she became delirious; the pulse very frequent, about 160. Soon after this she was seized with violent and general convulsion, which recurred very frequently through the early part of the night, leaving her in a state of profound coma. The treatment adopted during the course of these symptoms was repeated—general bleeding, to the amount of 28 ounces, followed by topical bleeding, purgatives, antimonial solution, &c. Towards midnight the convulsion ceased, and some time afterward she gradually recovered from the coma. On the 28th she was free from any alarming symptom; during the early part of the day, pulse about 108. In the evening she was seized with severe symptoms of pneumonia, on account of which she was bled during the next twenty-four hours, to the amount of upwards of thirty ounces, besides bleeding with leeches and the other usual remedies. In a few days more she was restored to perfect health.

Case 46.—A lady, aged 45, after the menses had ceased for four months, was seized with headache, sense of weight in the head, much oppression, and double vision; the pulse was at first 72, but soon rose to 100. On the first day she was bled to twenty-eight ounces, with little relief. On the second, topical bleeding, blistering, and smart purging were used, but the symptoms continued unabated. On the third day, another bleeding of twenty ounces gave a turn to the complaint, and, in a few days more, with brisk purging and spare diet, it terminated favorably. The last symptom that yielded was the double vision. It subsided slowly, the two images gradually approaching nearer to each other; but it was not entirely gone for nearly a fortnight.

"Bleeding by leeches," says Dr. Holland,* "from the hæmorrhoidal vessels might be much more frequently employed than it is in affections of the brain, as well as in those of the spinal cord. I know no mode in which a given quantity of blood can be removed with equal effect in the cases where it is required. It may be difficult to give strict anatomical reasons why this should be so; but what we know on the curious subject of the changes of balance in circulation, will, at least, furnish illustration of it. Nor can I doubt that something here is due to that peculiar relation between the blood in the portal circulation and the functions and diseases of the brain, of which experience affords so many remarkable proofs. For the practice itself, we have especial argument in the frequent alternation of bleeding, hæmorrhoids, with headaches, and other graver affections of the head; and also in the serious effects which sometimes ensue upon the suspension of such discharge, after it has long been habitual to the system."

Dr. Prichard† observes: "The fact, that evacuations of blood from the head fail to afford relief in many cases of nervous disease, is by no means a decisive proof that the affection, in this particular instance, does not depend upon, or is not connected with, increased vascular fullness in the brain, since we often experience a similar disappointment in those cases where we know the disease to consist in an overdistended state of the vessels."

* P. 55, op. cit.

† A Treatise on Diseases of the Nervous System, 1822, p. 236.

Dr. Prichard* relates some interesting cases of maniacal disease cured by the supervention of contagious fever. He had, he says, "an opportunity of frequently witnessing the effects of fever communicated to maniacs, as male lunatics are placed in the same ward with persons laboring under contagious fever." I will select the following, as I think it illustrative of the pathology of insanity. The observations which follow I entirely concur with.

Case 47.—Anne Jaunery, admitted June 17, 1817.

Description.—A married woman, aged 28 years, the mother of three children. She is of a tall and slender make; has brown hair, dark gray eyes, low forehead, sharp features; her natural disposition is irascible.

History.—She has never been before affected with maniacal symptoms; this attack is supposed to have been produced by intemperance. Her husband is insane, and is confined in this house; his disorder is attributed to vexation in consequence of the loss of property.

Present state.—She is extremely irritable; talks incessantly on different subjects; frowns, and closes her eyes as if intolerant of light.

Treatment.—Shave her head; Haust. Cath. nocte maneque; house diet.

July 20.—The purging has been continued; little or no amendment; cold shower-bath; continue the purgatives.

Aug. 17.—No improvement has taken place; pulse full, not quickened; complains of weight and pain in the head; is drowsy. She has had an interview with her husband; neither of them appeared to be aware of their situation. V. S. et fluant sang. ℥xvj. Syncope followed blood of loose consistence; the bleeding relieved her. From this time she continued occasionally with pain in the head, attended with increased pulsation of the carotid and temporal arteries, and a renewal of her restlessness and maniacal symptoms, which were generally relieved for the time by the application of leeches to the head, blisters to the nape of the neck; her bowels were constantly kept open, and she generally used the shower-bath.

About the 2d of January, 1818, she had a slight attack of contagious fever, which subsided in about a week. From that time she gradually recovered, and was discharged, cured, on the 26th of the following June. Full diet was allowed her from the time of her becoming convalescent from fever.

Observations.—This was evidently a case of inflammatory congestion of the head. It was excited by dram-drinking, and relieved by local depletion; but not cured, until a new disease took place, which altered the determination of the vascular system, and overcame the tendency to congestion in the head.

Purgatives and mercury are our most valuable allies in combating inflammatory disease of the brain. Dr. Abercrombie says, "In all the forms of the disease, active purging appears to be the remedy from which we find the most satisfactory results; and although blood-letting is never to be neglected in the earlier stages of the disease, my own experience is, that more recoveries from head affections of the most alarming aspect take place under the use of very strong purging than any other mode of treatment." Dr. Abercrombie preferred croton oil as the most convenient. I generally give calomel in five-grain doses, as we thus obtain the benefit of the specific powers of this mineral in restraining inflammation, as well as its purgative effects.

The following case, from Dr. Abercrombie, illustrates the power of purgative medicines in these diseases:—

Case 48.†—A gentleman, aged 17, 1st February, 1810, had symptoms of continued fever for a week; the skin then became cool, and the tongue clean; but he had severe headache, with considerable stupor; pulse 100. General bleeding was then employed, followed by purging and mercurial frictions, and after a few days the symptoms were alleviated; but there was still much headache, with oppression, and considerable slowness of speech. On the 14th there was increase of stupor; pulse 86; the tongue clean; the skin cool. On the

* Op. cit., p. 72.

† Op. cit., n. 160, Duodecimo.

16th there was much incoherent talking and unmanageable delirium; after which the stupor again increased, the pulse continuing at 84. On the 19th, there was partial relief, after smart purging; but on the 20th the stupor had returned as before, and by the 22d had increased to perfect coma; the pulse about 100. He now lay in a state of perfect coma for four days, during which time various medicines were given with difficulty, and with little effect upon his bowels. On the 27th, purging was produced to the extent of fourteen evacuations in the day, with complete relief of all his symptoms. On the 28th there was some delirium, which subsided in another day. For a week he continued to complain of some headache, and a feeling of weight in his head, but by the 10th of March he was free from complaint.

Cold applications to the head are invaluable; on the whole, pounded ice in a large bladder is perhaps the best. If this cannot be procured, then any evaporating lotion, such as spirit of wine and water, but this must be constantly changed; and the effect is very much increased by a current of air thrown upon it with the bellows.

The best refrigerator, after all, is the cold douche, but then the patient should be in a warm bath; or, if this is not possible, his feet should be placed in warm water. It can always be administered by pouring water from a height of about five or six feet out of a common washing-stand jug. It is so powerful a remedy that it must be used with caution. The writer, to whom I last referred, says that he has seen, under the operation of it, a strong man thrown, in a very few minutes, into a state approaching to asphyxia, who immediately before had been in the highest state of maniacal excitement, with morbid increase of strength, defeating every attempt of four or five men to hold him.

Regarding the use of cold to the head, Dr. Henry Holland makes the following excellent practical observations:*—

"There are one or two lesser points in the treatment of affections of the brain deserving more discrimination than they usually obtain. One of these is the general use of ice, or other cold applications, to the head. Any influence of cold, through its effect on the capillary vessels of the head, is at least ambiguous in such cases; and though its direct sedative effects on the nervous system may afford more certain warranty for the practice, yet these require to be distinguished and watched over in their progress. For, even where relief is distinctly obtained from cold suddenly applied after embrocation, it by no means follows that this application, long continued, will produce or maintain a like benefit. It is well known in various parts of practice how far it is otherwise; and that the effect of cold upon the circulation and nervous system is sometimes even reversed, according to the amount and manner in which it is applied. Or allowing, as I readily do, that there may be a distinct sedative effect from cold, beneficial in cases of inflammation of the brain or its membranes, will this equally apply to apoplectic cases, where pressure occurs from fullness of vessels or extravasation? If the relief to some kinds of headache be alleged, it must be remembered that other headaches are increased by this means. The same disparity, doubtless, exists as to the more serious affections of this organ requiring discrimination wherever we can exercise it. Unfortunately these are cases in which, generally, patients can render least aid. Sometimes they are manifestly uneasy under the application of cold. Their feeling, whenever it can be ascertained, is better than any other test."

* P. 47, *op. cit.*

I have found aconite, antimony, and digitalis, each and all most useful medicines in subduing inflammation of the hrain.

The value of aconite is well shown in the case of Betsey Rankin—Meningitis from fracture of the skull. Antimony I have not used much, as I have considered it too depressing in its operation. Digitalis is more useful in chronic cases than in the acute.

I have long felt convinced that much of the obscurity, which envelops these diseases, and those of other parts of the brain, might be removed by comparing them with diseases of the eye; viewing them through the light which the observation of this interesting class of affections affords us. I do not refer so much to acute disease as chronic, though both are useful as instructors. One great reason why these affections of the eye ought to guide us in our treatment and prognosis of inflammation, both chronic and acute in other organs, is the facility with which we can observe the action of remedies, medicines, topical applications, general stimulants, and diet, upon an organ so open to observation. I believe that every form of mental derangement is dependent on some change, though often very slight and temporary, of the vital condition of the hemispherical ganglion.

I am convinced that the reason why physicians, to whom the treatment of the insane has been entrusted, believe in the existence of mental disease unattended with disease of the instrument which the mind employs in its communications with the world, is because the medicine, both constitutional and local, has so little control over these diseases, and the great good to be derived from moral treatment. A knowledge of the treatment of diseases of the eye would teach them a different lesson. Let any man ignorant of the treatment of ophthalmic diseases attempt the cure of a case of strumous ophthalmia; he would, in all probability, seeing the red, inflamed conjunctiva, the pain suffered by the patient, and the distress occasioned by the presence of light, employ all the most approved antiphlogistic measures. He would bleed from the arm, purge violently, and then possibly put his patient under the influence of mercury. What would be the consequence? Why, most assuredly the loss of the eye, total blindness. And the same sad results followed the treatment of insanity when it was considered to be an inflammation of the brain, except in very acute cases occurring in subjects with much constitutional power; injudicious treatment being attended in the one case with the loss of sight, in the other with the loss of intellect. But suppose a judicious surgeon, one bred in the school of Farre, Travers, Lawrence, and my late respected colleague, Frederic Tyrrell, called upon to treat this strumous inflammation of the eye. He would support his patient's general health with a tonic plan of treatment; he would improve the condition of the circulating fluid and the instruments which circulate it. He would endeavor to arrest local inflammation by small local blood-lettings, counter-irritants, and astringent lotions, by removing him from all those atmospheric influences and moral circumstances which would stimulate the organ. And thus he might *ultimately* succeed; but what care, what patience, and what confidence in the remedial agents employed, does it require on the part of the surgeon who treats these cases, to effect a cure!

If, then, it is so difficult to subdue an inflammation in an organ, the actual condition of whose blood-vessels we can view, to which we can actually apply local remedies, and from which we can withdraw the injurious agents which have produced this inflammation, and exclude the natural stimulus of the organ, and see, in the whole course of our remedial measures, the progress or the failure of each particular plan of treatment, is it astonishing that men should have failed so much in the treatment of chronic and strumous inflammation of the arachnoid, pia mater, and hemispherical ganglion, when they have all these difficulties to contend with, and want many of the adjuncts?

Mr. Tyrrell, in his lectures, used to relate, in illustration of the importance of a generous diet and tonic medicine in the cure of chronic asthenic ophthalmia, the case of a young gentleman who was brought to him by his father, an intelligent medical man, on account of the obstinacy of the ophthalmia from which he was suffering. The father had been employing antiphlogistic measures. Mr. Tyrrell said, "Before I prescribe for your boy, go and give him a good dinner, and a pint of porter." The father was thunderstruck, the boy delighted, for he had had nothing but water-gruel, &c., for the previous week. The father did as he was told, the same principle was extended to the prescriptions, and the boy soon got well.

Now, supposing that this inflammation, instead of being of the eye, where it could be seen, had been an inflammation of the brain, where it could not be seen, the existence of which could only be conjectured from symptoms, and the physician had prescribed the same phlogistic treatment, with the same success, he would adduce it as a proof that there had been no inflammation at all.

Again, the cures that are effected by moral treatment alone, are often brought forward as a proof that mental diseases are unconnected with, and independent of, corporeal diseases. It would be just as correct to say an inflammation of the eye was no inflammation of the eye, because such inflammation is sometimes cured by placing a patient in a dark room, and removing the part from the injurious stimulus of light and atmospheric influences.

The moral treatment of the insane is no more. It essentially consists in the removal of injurious stimuli, soothing and tranquilizing the organ.

Strumous ophthalmia has been alone adverted to in illustration of this view, but there are many other ophthalmic affections which are equally in point, and the consideration of which will, I think, be found equally instructive: iritis, choroiditis, and amaurosis, but especially the last.

The treatment of iritis is chiefly instructive in demonstrating the superiority of mercury over blood-letting in subduing a deep-seated inflammation, and the necessity of bringing your patient rapidly under its influence, to prevent the consequence of adhesive inflammation.

Amaurosis, consequent on chronic choroiditis, is, I believe, almost pathologically identical with mental imbecility, consequent on chronic meningitis.

In the first case, the delicate structure of the retina, the vesicular neurine which expanded on the optic nerve, has been pressed upon by

its vascular and serous membrane, the choroid and membrana Jacobi, thickened by morbid deposit.

In the second, the vesicular neurine of the hemispherical ganglion is pressed on by the thickened pia mater and arachnoid.

And most certainly the success which attends perseverance in the treatment of chronic choroiditis and amaurosis ought to encourage us to similar patience and perseverance in the treatment of chronic meningitis.

I have known Mr. Tyrrell cure most obstinate cases of amaurosis by persevering in the administration of small doses of mercury, generally two grains of gray powder every night, or every other night, for twelve months, taking care never to affect the mouth. Indeed, he used to say that he has often seen the cure of such a case arrested, sometimes entirely prevented, by rapid salivation, in consequence of the impatience of the invalid, or want of judgment on the part of the practitioner. Mr. Tyrrell told me that he had often given mercury in small doses for two months without any improvement in vision, but this has not discouraged him, and that, by proceeding with the plan, he has ultimately restored many a poor fellow to sight, whose case had been abandoned as hopeless. Mercury is in disrepute in the treatment of insanity, because, as I believe, it has not always been judiciously administered.

Mercury will often restore the sight in amaurosis, even where the perception of light is destroyed. Mr. Tyrrell used to consider that a case was not entirely hopeless, if the globe retained its natural consistency; neither abnormally hard, or soft and shrunken: for when the disease is of very long continuance, then the retina and vitreous humor become sometimes implicated in the morbid action, and partial atrophy ensues.

If we could apply the same test in our diagnosis and prognosis of cerebral affections, we should administer our remedies with more confidence, as it is almost impossible to say when the ganglion has become atrophied, and when it is still unchanged in structure. In these amaurotic cases it is not merely necessary to sustain the mercurial action for months, but at the same time the power and tone of the patient's constitution must be sustained by a good nutritious diet and a moderate quantity of stimulus. Mr. Tyrrell's words are,* "I consider that the safety of the treatment, and its efficacy, depend very greatly upon the support of the general power; for whilst this is properly sustained, I believe that the remedy cannot produce any general injurious effect, though its operation upon the local disease may proceed most beneficially. Unless the general power be maintained, the effects of the mercurial action on the system are extremely distressing and injurious; and it can rarely be continued long enough to remedy the amaurosis." These observations result from great practical experience; not only in ophthalmic diseases, but in other surgical affections, in which the continued and free use of mercury is of the greatest use in arresting and subduing diseased action.

Case 49.—Mr. T. relates the case of a man about thirty-eight years of age, who had been amaurotic for seven years, and had lost the perception of light; but the globes possessed their natural firmness and elasticity; the pupils were clear, but irregular, from many points

* Cyclopædia of Surgery, i. p. 91.

of adhesion between the pupillary margin of the iris, and the anterior capsule of the lens; the irides were discolored and dull, and he had the vacant aspect of a blind person. I admitted him into the infirmary, then in Charter-House-square, and put him under mercurial treatment, with a nutritious diet; as soon as the mouth became tender, a considerable degree of sclerotitis occurred, with pain and tenderness of the eyeballs; the plan was, however, steadily continued, and some belladonna was applied, night and morning, to each eyebrow; he soon became sensible of light, and gradually acquired the power of discerning objects, and, at the same time, the adhesions between the iris and the capsule of the lens began to give way, and the pupils to re-assume their natural figures; by degrees the vision improved, all appearance of inflammatory action subsided, the pupils became nearly regular, and the irides brilliant; the full mercurial action was kept up for above sixteen weeks, when the amaurosis was completely subdued, and his vision perfect. For about sixteen weeks he discharged about a pint and a half of saliva daily, but in spite of the severity of the treatment, he came out of the course improved in appearance and evidently increased in bulk.

The more I see of these affections of the brain, the more am I convinced that the same rules ought to guide us in the treatment of these cases and ophthalmic affections. The great indisposition to the use of medicine on the part of those to whom the medical treatment of the insane is entrusted impels me to strengthen my position by such authority as Mr. Tyrrell's. I know many medical men who decidedly avow that medicine has no control over insanity, and that they never think of giving medicine unless the secretions are at fault, and there is general fever. Mr. Tyrrell's observations on choroiditis so exactly accord with my ideas regarding meningitis, that I shall quote them.* The italics are my own.

"The commencement of organic disease of the choroid, although unattended by any marked symptoms of inflammatory action, demands serious attention and careful management; *the patient being otherwise constantly liable to a sudden burst of inflammation and its consequences.*

"The existence, then, of a network or gauze, or the appearance of large spots in the field of vision, unaccompanied by pain or uneasiness, or any other evidence of increased action in the vessels of the conjunctiva or sclerotic, should meet with prompt attention and careful treatment, by which the integrity of the organ may be in most instances restored, and, at all events, useful vision preserved.

"*The organ should be perfectly rested*, and kept from exposure to bright light. Counter irritation, by means of blister or tartar emetic ointment, should be created upon the forehead or temple; the diet should be adapted to the power of the patient, but he should avoid stimulating food or drink, (beyond that which habit may have rendered necessary,) and such matter as is not easy of digestion, or is incompatible with the medicine employed.

"Medicinal treatment should first be directed to correct errors in secretion, and restore the disordered functions, the accomplishment of which is frequently sufficient to subdue the ocular disease; but should the vision continue disturbed, the alterative mercurial course should be adopted and the local remedies continued. It is very rarely necessary to produce mercurial action in the system."

He directs that *blood should always be taken away in moderation, and only in sufficient quantity to relieve congestion, but not to affect the general circulation; that in "many cases, when the disease is apparently acute, but*

* P. 90.

the power feeble, the loss of blood aggravates rather than benefits the affection; this I have observed most frequently in young and delicate females. I have known the continuance of depletory treatment prove most injurious in augmenting the morbid action and hastening disorganizing process."

"Unfortunately, as relief frequently follows the local abstraction of blood, the patient in every fresh attack or relapse is desirous of resorting to the same treatment again, and the medical attendant, unacquainted with its injurious effects, readily adopts it; the relief is, however, of short duration, and this burst of acute symptoms in a few days occurs. The same remedies are again resorted to with similar effect, but the patient is further reduced in power, and the local disease has made some progress in disorganization. Under continuance of this treatment the patient suffers from repeated attacks of the acute kind, each of which produces an increase in the amaurosis, and eventually vision is completely destroyed, while at the same time the general health is materially deranged, if not permanently injured. I have seen several very distressing cases of permanent amaurosis resulting from such treatment; and I have also known many instances in which the disease has been arrested and vision preserved, by raising and maintaining the general power, and pursuing the medical treatment which I have recommended, after many weeks of depletion had failed to produce the desired effect."

The following case shows the value of this plan of treatment in chronic meningitis with some serous effusion:—

Case 50.—A lady, aged 48, a married woman, but without any children, consulted me on the 8th of December, 1841, for drooping of the right eyelid and violent pain in the head. The right eyelid droops over the eyeball, and she can only raise it half way. The left she has complete command over. There is a quivering motion in both eyelids and eyeballs. When she closes the left eye, and attempts to look at anything with the right, she finds her vision very imperfect and misty.

She complains of a shooting, pricking pain in the ball of the right eye, with a feeling of great pressure and pain on the left side of the head and face.

She says she sometimes has feelings as if she was not right in her mind, as if she were going delirious. These feelings existed previous to the eye being affected. Her countenance is rather wild and anxious; the eyes staring and unnatural.

She complains of sensations in the body and extremities, which she calls "live blood," or "pins and needles," as if there was something fluttering underneath the skin; sometimes the right eyeball flutters so violently that it feels to her as if it would jump out of her head. The right arm and leg sometimes are numb, but the left never feels so

She passes, per anum, from piles, nearly a pint of blood during the week, which she considers gives great relief in the head.

I found, on inquiry, that she had been much harassed latterly, and suffered much anxiety of mind.

About six years ago she had a bad miscarriage, since which the womb has been displaced, and it has become hard and shrunken, and prevented all connection for two years. She has only menstruated once during the last two years, and that occurred about two months ago, and she felt relieved by their appearance. Pulse quick and irritable; tongue rather pale, but not furred; appetite pretty good; sleeps tolerably; feels very weak.

Ordered Hyd. c. Cretâ gr. ij. nocte maneque. Emp. Lyttæ fronti.

After using the mercury in doses varying according to its effect, and never so as to salivate, with various counter-irritants, issues, &c., at the same time supporting the general health for two months and a half, the paralysis of the eyelid was entirely cured, and the pain in the head left her, and, as she felt nearly well, she left off her medicine, and I lost sight of her for above two months, after which time she came to me again.

Her countenance is worse; the right eyelid again droops. She says that all her sufferings are returned as bad as ever, though her general health has improved. The pain at the back of the head is most violent, and the burning sensation at the top of the neck so severe that she can scarcely contain herself; at times something seems to pass over the eyes so as to make her blind. Sometimes the sensations are so horrible that she feels as if she were going mad.

She has some loss of power on the right side, across the right leg—it feels numb and heavy. Moral causes appear to have produced this relapse, though she says that soon after the mouth became well from the mercury, she began to feel uncomfortable. This time I was obliged to cup her three or four times, as well as employ mercury in full doses. She came under my care, on this occasion, on the 13th of April, and it was not till the 22d of June, that I could report any decided improvement; by this time she was able to walk pretty well, her head felt easy, and she says she can now use her reason.

I continued the mercury for four months, at the end of which time she was quite well. Her sight was quite restored; no pain in her head; feels strong and hearty; spirits good; mind equable and placid. Her countenance is entirely changed; instead of a staring, wild, unnatural expression, she looks composed and comfortable. She expresses herself grateful for her recovery.

I have been gratified in finding the following observations on the use of mercury in such cases from the pen of that admirable surgeon, the late Mr. Colles,* of Dublin, whose work on the treatment of syphilis is one of the best in the English language.

"I now merely wish to report the result of my own experience, as to the efficacy of mercury in some classes of disease, in which, as far as I know, it has hitherto been but seldom, and even then but sparingly, employed. I allude to certain derangements of the brain and nervous system, sometimes accompanied with more or less of paralysis of the voluntary muscles. In these diseases I consider mercury, when actively, and at the same time judiciously, administered, to be a most invaluable medicine.

"This position, I think, I can best establish by a brief statement of a few cases, which I have selected out of several that have fallen under my own immediate observation."

Colles gives eight cases, all of which are interesting and instructive, but I must refrain from quoting more than one. This I have selected because it is of that class which I believe ultimately terminates in mental imbecility.

Case 51.—Oct. 3d, 1836.—Mrs. B., of Rathmines, æt. 50. For nearly the two last years, this woman has suffered many severe family afflictions, and considerable loss of property, in consequence of which, as she thinks, she has become subject to what she terms "great confusion in the back of the head," which of late has extended to the right side of the head also. She has latterly avoided all society, and has sought for solitude. At the same time she observed a failure of memory, which, within the last six weeks, has increased considerably, so that now she cannot find words to express her ideas. If she chance to lay a key or anything out of her hand, she cannot, in a minute after, recollect where she had placed it. She is unable to read, as the attempt instantly brings on the "*confusion* in the head; if she attempt to recollect anything, it all ends in the same confusion; nor can she even attempt to do any needlework, as this would be followed by the same distressing sensation. Her temper has become extremely peevish and irritable; she suffers from a constant sickness of stomach like sea-sickness. When she attempts to walk, she staggers, as she says, in consequence of a dizziness in her head, yet she can walk in a dark room; nor is she alarmed by looking down from a height. Her appetite is good; the bowels are very costive; she sleeps very heavily; there is no emaciation; pulse 96. I determined, in this case, to try the effect of ptyalism; and having prescribed a strong purging draught, directed calomel gr. iij. bis in die.

Oct. 7th.—She has had a slight attack of mercurial dysentery yesterday, with some soreness of the mouth and gums; she describes what she terms the confusion in the back of the head as being much less; there is a decided improvement in her memory; she can now much more readily and more constantly find words to express her ideas. She has some sickness of stomach, but different from that kind of sickness she has so long suffered.

Oct. 10th.—She can now read and attend to figures, and can even cast up an account, which she could not previously attempt to do; but still she feels she would become confused

* On the Use of Mercury in Affections of the Nervous System. By Abraham Colles, 1837, p. 328.

if she attended to them beyond a very short time. Habeat Haust. c. Quinæ. Sulph. gr. ij. his in die.

Oct. 18th.—Whenever she stoops or turns about her head suddenly, she feels a sense of confusion, and then a pain in the head. Her sleep is less heavy, and much more refreshing; she can now read as much as twenty pages of a book at once. She takes an interest in it, and can recollect what she has read. Says she feels as if some great weight had been lifted off her; ptyalism was still maintained by occasional doses of mercury. Habeat Ungt. Ant. Tart. Vertici capitis.

Oct. 24th.—Pustules have been produced by eleven applications of ointment. She can now stoop, and look up suddenly, without any unpleasant sensations; her memory and spirits are improving; she can now attend to her household affairs, and can recollect what she has to do.

Nov. 3d.—She now reads with interest, and recollects what she has read a week before; her temper is still very irritable, especially if hurried; her spirits are much better in the latter part of the day—in the morning she feels very nervous; jolting of the car makes her head still feel a little giddy.

Nov. 13th.—She feels much improved in every respect; she becomes fidgetty and uneasy at 10 P. M. before she goes to bed;—this is the principal nervous uneasiness she now experiences. She feels her temper much improved since the scalp has healed.

Nov. 16th.—She walked from Rathmines to my house, upwards of a mile, this day, and feels no inconvenience except a very slight giddiness. Her sleep is now refreshing and natural, her temper much improved; she does not now suffer from confusion when she is hurried.

I observed, that during the entire treatment, her bowels required very active aperients, the uneasy feelings in her head uniformly becoming aggravated by costiveness.

Dr. Alison,* in speaking of the symptoms which mark those "cases of active inflammation within the cranium, such as bear evacuations best, and are most generally and decidedly benefitted by them when used early and carried to a due degree," after mentioning the ordinary symptoms, such as pain, impatience of light and sound, sickness and vomiting, adds, "great aggravation of the uneasy feelings in assuming the erect posture." As a general rule, I find the contrary: that the recumbent posture is the most comfortable in anæmia, the erect in hyperæmia. It is possible that all he means is, that every kind of motion is painful; and there I agree with him, but not that it is limited to the inflammatory affections. He agrees with most pathologists in objecting to the use of opium in these affections. He is strongly in favor of general bleeding in all well-marked cases of inflammation of the brain and its membranes. He says: "The bleeding should be general and local, but the former is by far the most important; and it may be laid down as a general rule, to trust no case to the local bleeding only beyond the age of five years. There are some cases, particularly in adults, in which the inflammation lasts very long, or returns very frequently, and ultimately abates completely, under repeated local or even general bleeding, without stupor, delirium, or spasms, ever supervening; while in others, those results of the disease show themselves within a few days."†

Dr. H. Holland makes some excellent observations on the use of mercury, particularly the bichloride, in affections of the nervous system, especially supporting my opinion of the value of its continuance. He says:‡ "Perseverance in the use of bichloride of mercury is of singular avail in certain cerebral or spinal disorders—to obtain the full benefit, we must be patient as well as decided in its use." He refers to one very interesting case.

* Outlines of Pathology, &c., 1844.

† P. 344, op. cit.

‡ P. 250, op. cit.

Treatment.—Recapitulation.—In the treatment of all inflammatory affections of the brain, the following broad principles must always be attended to:—

1st. There is no time to be lost—even minutes are of value.

2dly. That inflammation of the brain is a depressing disease, and that, as a general rule, general blood-letting is not often admissible.

3dly. That, though general blood-letting may sometimes be attended with benefit at the time, the good derived from it is seldom permanent.

4thly. That local blood-letting, by leeches and cupping, is generally useful, and especially in cases of insomnolence, arising from abnormal action of the brain.

5thly. In cases of insanity, where opium has failed to produce sleep, leeches and cold applications frequently will; and if they do, it is strong evidence that the excitement arises from hyperæmia, and not from anæmia, as in that of delirium tremens.

6thly. That aconite and digitalis are the best sedatives, especially when combined with mercury.

7thly. When it is advisable to salivate rapidly, raise the cuticle by boiling water, or a similar escharotic, and dress the surface with the strong mercurial ointment.

8thly. Always commence the treatment with a brisk mercurial purgative.

9thly. Soothe the patient's feelings in every way.

10thly Never leave anything that is disagreeable to the patient to be done by a nurse or attendant, such as the application of leeches, &c., but *persuade* him to have them applied.

11thly. Never lose your patience in the treatment of a chronic case, or try to hasten the cure by increasing the doses.

12thly. When it is considered necessary to continue the use of mercury for a lengthened period, combine tonics with it.

Apoplexy.—The term is derived from the Greek word αποπληξω, *to strike;* hence the common appellation, an apoplectic stroke, or a stroke of the palsy.

Apoplexy, long as this term has been familiar to the profession, still conveys a very indefinite meaning. Some authors use it to distinguish a particular class of symptoms and effects of disease; others to designate the pathological condition which gives rise to those symptoms.

I think that it is applied too generally to the effects of disease, instead of the cause. The classification of diseases of the brain which I have adopted is founded on pathology, not on symptomatology. I propose using it to designate *pressure on the brain*, or encephalon, produced by extravasation of blood or serum, or by distension of the vessels without extravasation, such extravasation not being the result of direct violence, as a blow upon the head. Wherever I employ the term *apoplexy*, I use it as synonymous with *cerebral pressure*, and I believe that all its varieties depend on the amount of the effusion and the part of encephalon injured.

This view of the subject will be exposed more clearly as we proceed.

Apoplexy, in its most aggravated form, is an awful disease to suffer from, to witness, or administer to.

A man, in apparently good health, suddenly falls down deprived of

all his senses, wholly unconscious of surrounding objects. The countenance livid, the vessels of the face and head turgid with blood, the breathing stertorous, slow, and laboring; the limbs lie powerless; the pulse is full, slow, and intermittent: from this state he never rallies, sinks without any change, and dies in the course of forty-eight hours. His brain, when examined after death, is found to have been more or less torn and destroyed by extravasated blood.

This may be considered as a *typical* case of apoplexy, but this description of it will no more include all the varieties of this disease, all the aberrant forms of the complaint, if we may so speak, than the description of the characteristics of the eagle would include that of the whole class of rapacious birds.

It is typical, because the extravasation is so severe that *all* the effects of extravasation are produced—*all* the centres of nervous power within the cranium are affected. The aberrant forms are merely slighter effects, from a slighter but a common cause.

It is said that apoplexy may be confounded with syncope, ordinary sleep, and epilepsy; but when we consider the above phenomena which, in a greater or less degree, always attend the apoplectic seizure, we must allow that they are peculiar to the disease.

In such a case as the above it could not be mistaken for syncope, for the patient is not pale and cold, the pulse is not feeble. It could not be mistaken for sleep—it occurred too suddenly, and the patient could not be awakened. It could not be mistaken for epilepsy, for there was no cry and no convulsions.

But there are some cases of apoplexy which might be mistaken for syncope, and others which might be mistaken for epilepsy.

Abercrombie arranges apoplexy under three forms of apoplectic attack, and very admirable are his descriptions. The first are those which are immediately and primarily apoplectic, using the term as synonymous with coma; the second are those which begin with a sudden attack of headache, and pass gradually into apoplexy; and the third are those which are characterized by palsy and loss of speech, without coma: classifying them according to the symptoms. If we reverse the order, we find that the first form depends upon such a sudden and extensive effusion into the hemispheres, that the powers of the hemispherical ganglion are at once arrested, as in a case of severe concussion of the brain. The second form of apoplexy, which might be mistaken for syncope, is thus described by Abercrombie:—

"The patient becomes pale, sick, and faint, generally vomits, and frequently, though not always, falls down in a state resembling syncope; the face pale, the body cold, and the pulse very feeble: this sometimes accompanied by slight convulsion. In other cases, he does not fall down; the sudden attacks of pain being only accompanied by slight and transient loss of recollection. In both cases he generally recovers in a few minutes from the first effects of the attack, is quite sensible and able to walk, but continues to complain of headache after a certain interval, which may vary from a few minutes to several hours; he becomes oppressed, forgetful and incoherent, and then sinks into coma, from which he never recovers. In some cases paralysis of one side occurs;

but in others, and I think the greater proportion of this class, no paralysis is observed."*

This form will be pathologically described as meningeal apoplexy. The effusion taking place on the surface of the vertex of the brain, and giving rise to headache, the effusion taking place in such small quantity, and so slowly that, the powers of the sensorium not being at once annihilated, the patient is cognizant of pain; the effusion continuing, till at last all the cerebral ganglia are compressed, and the patient dies comatose. Dr. Abercrombie remarks on the similarity of these cases to those extravasations from external injury, where the patient recovers from the first effect of such effusion, and is even able to walk home. The following illustrates this in a striking way:—

Case 52.—Laceration of brain, from a blow on the head without fracture of the skull.—May 7th, 1845.—I was this day, at nine o'clock, A. M., called in by Mr. Maybury, of Little Tower Street, to see Mr. T. F. C., Love Lane, Eastcheap, who was suffering from injury to the head.

He was about fifty years of age, and, as I learned from his daughter, generally of temperate habits. It appeared that, between five and six in the afternoon, he had been struck about the face and chest by another man, and that in falling he hit the back of his head against the pavement; he was rendered insensible by the fall, but became conscious on arriving at the London Hospital, whither he was conveyed. His wound was dressed, and the dresser advised him to remain at the Hospital; he, however, refused, saying that his wife would be rendered anxious by his absence. From Mr. Maybury I learned the following particulars, viz., that he was sent for on the same evening, and, on arriving at the house, found C. sitting in a chair near the fire, relating with all his usual reason the circumstances which led to the fall above mentioned. Mr. M.'s attention was immediately called to the profuse hæmorrhage issuing from the dressings on the head, on the removal of which dressings, two large incised wounds on the left side of the occipital bone were exposed. These wounds penetrated to the cranium, and were distant from each other about a quarter of an inch, each being an inch in length. Several small arteries were pouring out blood profusely. This bleeding being suppressed, the wounds were dressed simply with lint soaked in cold water. The patient was put to bed, when he was attacked with rigors. He was ordered a mixture of aromatic spirits of ammonia; camphor mixture and spirits of lavender. On the following morning, the 7th, Mr. Maybury called, and found him laboring under difficult and stertorous breathing, and presenting all the worst symptoms of compression; the pupils remaining fixed before the glaring light of a candle, the right dilated, the left contracted. These symptoms, preceded by a short attack of shivering, commenced immediately after Mr. Maybury's departure on the foregoing evening. Mr. Maybury bled him, and immediately afterwards called upon me. I found the patient breathing stertorously, and with great difficulty; in fact, he appeared almost moribund; his pulse varied, never full or strong, but every now and then gradually stopping altogether, and then going on again; it was not merely intermittent. Both pupils were fixed, the left contracted, the right dilated. There was a small wound, about one inch in length, behind the left ear. I put my little finger into it, but could not feel any fracture. This operation was evidently felt by him, for he moved his head about, and his stertorous breathing was altered, so as almost to amount to a groan. I tried if he could swallow a little water; but he was nearly suffocated by the attempt.

I ordered a turpentine enema ℥j. to the lbj. A blister to the side of the neck, to be dressed with mercurial ointment; and we agreed to see him again at about one, if he was alive. His head was shaved, and a cold spirituous lotion kept constantly applied. Mr. Maybury visited him several times during the day: he continued to grow worse, and died about five o'clock the following morning.

We examined the head, and found the following appearances, viz.—

Extravasation under the scalp on the left side extending to and through the left temporal muscle. Laceration of the under surface of the middle lobe of the brain on the right, with coagulated blood on the same side, amounting in quantity to about three or four ounces, between the dura mater and the brain. No fracture of the skull. Strong adhesions of the dura mater to the cranium. Brain otherwise healthy.

In this case death ensued from pressure, as in apoplexy, though the active external hæmorrhage delayed the fatal event.

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* Op. cit., p. 204.

The pallor and faintness which attend the class of apoplectic cases before spoken of, and which appear to remove them from true apoplexy, arise from the sudden loss of blood occurring from the vessels of an important organ. It is well known that a very small loss of blood from the vessels of the intestinal canal, the lungs, and other viscera, will cause great vital depression, while a much larger quantity may be removed from the extremities without the constitution taking the alarm. And thus it is with the brain, if its normal sensibility is not interrupted by the pressure of the extravasated blood. Again; the reason that this form of apoplexy differs from the typical form, in absence of congestion of those vessels of the head which are apparent to the eye, as shown by the red or purple countenance, is, that the proximate cause of the extravasation is not over-distension of the blood-vessels of the brain, but disease in their coats, which then suddenly break under the heart's action. If the patient recover his senses quickly, it is because the opening is very small, and the quantity extravasated in accordance with the aperture.

Abercrombie observes, and I believe truly, that these cases are generally fatal. This may be thus explained. We cannot by any remedial measures with which we are at present acquainted, alter this diseased condition of the coats of the blood-vessels, and it is seldom, if ever, that a rent in a diseased vessel is closed by that adhesive action by which nature repairs similar lesions in healthier tissues. We can moderate, for a time at least, the inordinate action of a diseased heart—we can relieve a vascular system, unnaturally distended with blood—we can prevent mental and cerebral excitement by judicious moral treatment—we can promote the absorption of extravasated blood, and thus it is that all cases of apoplexy are not fatal, and not irremediable; but in these cases of pallid, fainting apoplexy, such measures are of little use. These observations touching the treatment of apoplexy may appear premature, but I have thought them necessary in order to account for such *different* symptoms arising from pathological states so nearly *similar* and requiring nearly *similar* treatment.

In the third class the effusion takes place near the base of the brain, or in the motor tract near the anterior and posterior cerebral ganglia, and is so limited that it does not affect either the hemispherical—the intellectual ganglia—or the respiratory ganglia; and hence the absence of coma and stertor.

This class includes many cases which will be considered *seriatim* when we investigate the peculiar effect of effusion according to the portion of the encephalon injured.

Apoplexy may be again divided into three groups, in accordance with the matter which produces the pressure from which the apoplectic symptoms result—namely, extravasated blood, *sanguinous apoplexy;* extravasated serum, *serous apoplexy;* abnormally distended blood-vessels, *simple apoplexy.* In these latter cases there are no *post-mortem* appearances.

There is a state of brain that may be advantageously adverted to here which closely resembles the apoplectic condition, but which requires a very different line of treatment. I cannot pretend to say exactly what

the pathological condition is—but not anæmia; I suspect it is one of very partial congestion,—limited, simple apoplexy. The following case illustrates it:—

Case 53.—1847.—I was called to visit a gentleman in the city, who had been suddenly attacked with paralysis. I found him sitting on a stool in his office, perfectly conscious, but unable to articulate a word; he endeavored by signs to call my attention to his having lost the use of the whole of the right side of the body and extremities. On asking him his age, he made signs for pen and ink and paper, and wrote with the left hand, tolerably legibly, "49 or 50, also a bad cough." I found his pulse very variable in both strength and quickness, but not positively intermittent, nor laboring or jerking, soft and compressible. On my calling for a basin, he became excessively agitated, which I afterwards found arose from his being afraid I was going to bleed him. As soon as I got the basin, I poured cold water over his head with a jug, which operation I had scarcely commenced before he spoke quite distinctly, saying I am all right again: he then told me that the first uncomfortable symptom he had, took place about an hour previous; he wanted to put down on paper 108, but found his hand fail him, and he could not write more than 10: this annoyed him, and he made some excuse; the uncomfortable sensations were sufficient to frighten him, and induce him to send off immediately for medical assistance, but they passed off so quickly that he soon sent another messenger to say he was quite well, and left his counting-house to return home to Greenwich; but he had not proceeded far before they all returned, though to a much greater extent, reducing him to the state in which I found him.

Previous history.—A man of highly nervous temperament, exceedingly active in business, in which he has been a good deal harassed lately, leaving him scarcely any time for his meals, and giving him a great deal of anxiety: he had been repeatedly warned by his wife and friends that if he did not pay more attention to his health, he would have some serious illness; this they said from seeing him every now and then in a state of great exhaustion: he had also been suffering lately from hooping-cough.

It was very clear that stimulants were the only things indicated here in the first instance. I therefore gave him a small quantity of brandy and water, and some sal-volatile: in a few minutes after he had recovered his speech he recovered the whole use of his right side, declaring that he felt perfectly well, and determined to return home; we therefore put his things on and sent for a cab, but when he got up to go down stairs, he said, "I am afraid I am going to be ill again," and I asked him why he thought so: he answered, because I am losing the power over my hand and leg; and his speech began to falter; he then told me where he wished to be taken, lest in a few minutes he should not be able to speak. I gave him some more sal-volatile and brandy: in a few minutes more, all these unpleasant symptoms had again passed away, and we were enabled to proceed safely without any return of them, to his own house at Greenwich. On his way down he several times declared he never felt better in his life, and said it was very strange he should have been so ill such a short time before. At Greenwich, I left him in the hands of his own medical man, Mr. Watsford, recommending a warm bed, hot water to the feet, mustard poultices to the legs, and a mild aperient.

I have learnt since from Mr. Watsford, under whose care he remained, that he had one or two threatenings of a return of his illness, but that they were averted by the same general plan of treatment, and that he is now quite recovered.

The predisposing causes of apoplexy, though uncertain, still deserve consideration. A peculiar conformation may be mentioned; a full florid countenance, short neck. Advanced age is also a predisposing cause of apoplexy. Individuals seem to inherit from their ancestors a predisposition to this disease, occasioned, most probably, by a similar morbid condition of the coats of the cerebral vessels, or of the heart and its valves.

Other predisposing causes exist, but these are secondary, being dependent on disease of other organs, as organic disease of the heart and arteries, diseases of the lungs, sudden changes in the system, cessation of the menses or drying up of pus-secreting surfaces. Drunken habits may also be reckoned as a predisposing cause.

The profession have long been aware of the concomitance of diseases of the heart and diseases of the brain. When it was my duty to conduct

the *post-mortem* examinations at St. Thomas's Hospital, I scarcely ever examined a case of apoplexy without finding some disease of the heart and arteries, generally hypertrophy of the left ventricle, with atheromatous deposit in the coats of the vessels of the brain; and of course I pointed out to the students how both these diseases would in themselves and unconnected, facilitate sanguineous effusion; the first giving to the forcing pump undue power, which the vessels nearest to it would feel the most, and the second making that tube *brittle*, which in a state of health is elastic, though firm. I was therefore surprised to find from Dr. Burrowes' researches that so many writers on diseases of the brain, and among the number Dr. Abercrombie, should have omitted all mention of the influence of diseases of the heart in producing cerebral diseases. Dr. Burrowes says,* "In opposition to the opinions entertained by many respectable authorities that the quantity of blood within the cranium is at all times nearly the same, and that the heart does not influence the cerebral circulation, my own observations, supported by facts already detailed, convince me that in many, perhaps the majority of cases of apoplexy and hemiplegia, the primary disease is not situated within the cranium.

"I would go further, and affirm, that in many cerebral affections apparently depending on effusions of serum or blood, there is no further primary disease of the brain than there is of the cellular tissue in anasarca, or of the peritoneum in ascites, or of the skin in purpura, or of the stomach in hæmatemesis. There is, indeed, a palpable morbid condition of these several tissues and organs where the effusion or ecchymosis takes place; but it is generally dependent upon a morbid state of some other viscus which generally interferes with the circulation in the parts where the effusions are detected. An hypertrophied left ventricle, or valvular obstruction in the heart, will lead to lesions within the cranium, similar to those observed in the stomach and peritoneum when there is obstruction to the circulation through the portal veins in the liver.

"If the pathology of the brain in apoplexy and hemiplegia be analogous to that of other organs which suffer from effusions of serum and blood, how much must this knowledge improve the routine treatment of apoplexy, which has so extensively prevailed.

"Does not the view of the pathology of apoplexy render more intelligible those different varieties of the disease which are described by ancient writers, although they could not account for the differences?"

We must all, I think, accord with Dr. Burrowes in these opinions. It is very clear, that if Abercrombie's judgment had not been warped by his peculiar views regarding the cerebral circulation, he would have seen more distinctly than he did the relation between the *various* cerebral lesions, and their vital effects.

As a general observation, attacks of apoplexy are apparently sudden and unexpected, but on inquiry we frequently find that the subjects of the attack have been indisposed and out of health for a shorter or longer time; it is, therefore, important to consider the premonitory symptoms,

* Op. cit., p. 124.

which, if not attended to, would usher in an apoplectic fit. The patient will sometimes exhibit an unusual tendency to sleep, will sleep long and heavily, with laborious breathing, sometimes almost amounting to stertor; a constant dull pain in the head, and this, when the patient has not been previously subject to headache, should put us on our guard.

Vertigo, or swimming in the head, after stooping for a short time, the countenance exhibiting a livid hue, the veins on the forehead turgid, the carotids and temporals pulsating forcibly. Sometimes there is tinnitus aurium, partial deafness or blindness; double vision is also a common and very suspicious symptom. The mental faculties are more or less impaired, memory is lost, but more frequently only partially so. The most common terms and occurrences are forgotten, while the memory of uncommon words and circumstances is perfect; sometimes one word, of a totally different meaning, is substituted for another. The patient appears at times quite imbecile, temper irritable; at other times he remains in an apathetic condition, from which it is very difficult to rouse him. There is also generally a tendency to paralysis, which exhibits itself in various ways. Ptosis is not uncommon as a precursory symptom; or the patient may be unable to articulate his words from partial paralysis of the muscles of the tongue. Drawing of the corner of the mouth from palsy of the opposite muscles, an unsteadiness of gait, tripping over slight impediments, are one and all occasionally observed. Frequent cramps and numbness of the limbs, toes, or fingers, all exhibit a tendency to paralysis, and are consequently deserving of serious consideration.

Now although the above is a tolerably correct outline of the premonitory symptoms of apoplexy, it must not be supposed that such phenomena never present themselves except as the precursors of that disease. All of them will arise from a disturbed state of the digestive organs; it is, therefore, of the greatest importance to investigate the state of these organs before taking so serious a view of the case. Generally speaking, if we ask a patient whose brain evidently sympathizes easily with his stomach, whether he suffers from indigestion, he says, "Oh no, I do not know what it is." He has never been in the habit of connecting his uncomfortable feelings with his stomach. But we perhaps find, on a little inquiry, that he is very irregular in his diet, not resting quietly after his meals, and paying no attention to his bowels; that he has a foul tongue, stinking breath, and all the usual signs of dyspepsia. In doubtful cases an active aperient is the best medicine, and a little careful watching will soon decide as to the danger of an apoplectic attack; always bearing in mind that aggravated dyspepsia is itself a cause of apoplexy.

Mental excitement has already been considered as an important pathognomonic symptom of incipient meningitis; it must also be remembered as a possible forerunner of apoplexy. Dr. Conolly* says that he knew a very corpulent woman subject to hysteria, with some threatenings of paralysis of the left side, who described herself as feeling so well and lively before her worst attacks that she "could not always refrain

* An Inquiry concerning the Indications of Insanity. By John Conolly, M.D., 1830. London. Pp. 248.

from singing," showing that the capillary system of the hemispherical ganglion was at that time in a state of hyperæmia. In the consideration of such excitement, for the guidance of our diagnosis, we must, of course, attend particularly to the general character of the constitution, and the moral circumstances which have been lately influencing the patient. Case 35 is a good illustration of apoplexy induced by moral causes.

Sanguineous apoplexy presents many interesting points for our consideration, both in a practical, pathological, and physiological point of view. To some of these our attention shall next be directed.

In some cases of apoplexy the effusion takes place so slowly, and in such small quantity, that the real pathological character of the disease is easily passed over; especially with patients among the lower orders, who are not generally very clear in the accounts of their ailments.

The following case is very instructive from its insidious character, and as illustrative of the value of blood-letting and mercury in the treatment of this disease.

It is true that we happily had no autopsy to demonstrate the exact seat of the effusion, but I have very little doubt that it was in the right crus cerebri, and that the quantity was effused so slowly that the conducting fibres were not ruptured, only pressed on by the blood effused between them. If they had been ruptured, I think there would have been more or less spasm or convulsion.

Case 54.—Wm. Green, æt. 42, shoemaker, a married man, temperate in his general habits, but occasionally taking a little too much, but not so as to get drunk; leuco-phlegmatic temperament; no apparent hereditary predisposition to apoplexy.

July 5th, 1846.—Applied to me at the Dispensary for partial loss of power of the left leg and foot. On this occasion he merely complained of a pain in his loins, in addition to the loss of power; but said nothing to call my attention to his head. I ordered him to be cupped on the loins, and to take Pulv. Jalap. c. Cal. gr. xv. h. n. Haust. purgans cras mane. Cal. gr. ij. Opii gr. ¼, n. et m., low diet.

On the 8th, he complained of some numbness in the face and arm, and his speech was slightly affected. It was now evident to me that there had been some sanguineous extravasation into some portion of the cerebral mass, and most probably in the region of the right crus cerebri. I made further inquiries, and obtained from him the following account:—About four days previous to his first visit to me, he was attacked under the following circumstances:—His wife returned unexpectedly from the country with some friends about eleven o'clock; he welcomed them with a little extra beer and gin. After that he had his dinner, about one; and then went to sleep on his bed, as was his usual custom in the middle of the day. On waking, he found that he had lost the use of his foot, and it felt numb and pricking, but still he went on with his work as usual. Since the loss of power in his leg, but not before, he has had occasional sharp pains across his forehead, but they did not continue; he felt occasionally stupid in his head, but this went off again. He never lost his senses. As there was no great power in the pulse, or evidence of general plethora, I ordered him to continue the calomel.

15th.—His mouth is tender from the mercury; decidedly better. Ordered Mist. Iodin. et dec. Sarsaparillæ b. d.

19th.—Complains of his head. Ordered the Tinct. Iodinii Comp. to the neck and back of the head, as a counter-irritant.

22d.—He now complains of some feeling of giddiness, and great pain in his head; bowels confined. Ordered C. Cruentæ pone aures. ad ℥xij. Cal. gr. ij. nocte maneque. Leave off the Sarsaparilla.

Aug. 5th.—Much relieved; can walk better; in his head there is less pain, and this is confined to a spot about the size of half-a-crown. Ordered, C. Cruentæ Occipiti ad ℥viij.

Aug. 15th.—Much better; free from pain in the head; he can move his arm; face better; can move his toes a little, which he has not been able to do before this time since his seizure. Continue the calomel.

Sept. 29th.—Has continued the mercury, and he has been gradually improving in health and strength since the last report. He is now able to walk nearly as well as ever; all the signs of paralysis have nearly disappeared in the face and arm, both as regards the numbness and the expression of the countenance. After this, I lost sight of him until the 20th of November, 1846. About four years since the loss of power in the leg, but not before, he has had occasional sharp pains across the forehead, but they did not continue. He felt occasionally stupid in his head, but this went off again. He never lost his senses. When he first applied he did not complain at all of his head, but only of his leg. He was ordered an active aperient. Pulv. Jalap. gr. xv. Calomel gr. v. statim sumendus M. S. C. mane. C.C. lumbis ad ℥vi. Cal. gr. ij. Opii. ¼ n. et m.

The effects of sanguineous apoplexy are very varied, depending on the extent and the seat of the effusion.

Beginning with the *medulla oblongata*, effusion *into* this part is more *suddenly* fatal than any other. It is the only form of fatal apoplexy that resembles and is liable to be mistaken for death from disease of the heart. It very seldom occurs, for this part is not very vascular; the vessels are not large, and they are well supported. Effusion more frequently takes place *on* the surface of this part than into its substance, and then it proves equally fatal, only not so suddenly. The reason of effusion into this respiratory centre proving so rapidly destructive to life, must be obvious to every physiologist. It is from this centre that the nerves of respiration and the muscles which they command receive their power of action. When blood is effused into the third ventricle from rupture of the vessels of the thalami or corpora striata, it gradually finds its way down to the medulla oblongata, and this is a very frequent termination of such cases.

When the effusion is first into the transverse commissure of the cerebellum (*pons Varolii*), and secondarily into the medulla oblongata, the effects are often most interesting and instructive to the physiologist; and, *vice versâ*, the symptoms are so characteristic that the lesion may be easily recognized by the practitioner. Effusion into the pons Varolii produces paralysis of one or both limbs, according to its extent; but after the first effect of the effusion is over, it does not affect the intellect, as the hemispherical ganglion is left intact. As the blood advances to the medulla, so are the respiratory organs affected; first, the muscles of respiration are unnaturally and irregularly stimulated, and the sensibility of the respiratory passages abnormally exalted, until the excitation is succeeded by paralysis, and the patient dies suffocated. This next case, related by Ollivier,* is peculiarly instructive. The following, from Abercrombie, is equally so, showing the absence of all symptoms of injury to the respiratory system, and the confinement of the extravasation to a small portion of the pons.

Case 55.—*Spontaneous hemorrhage and rupture of the cephalic bulb of the spinal marrow and of the annular protuberance.—Convulsive contractions of the limbs.—Stertorous respiration.—Death at the end of five hours.*—M. D., a middle-sized man, large head, short neck, broad shoulders, and large abdomen, very muscular, being at work in open air, complained suddenly of a ringing in the ears; some minutes after he screamed from acute pain; he arose, commenced to run, as if to escape the danger which threatened him. After having run for a short distance he fell, and presented the following symptoms:—Complete loss of consciousness; face pale; immobility of the pupil, which is not dilated, and is of the same diameter on both sides; eyelids at first half closed, and completely approximated (the upper lid of the right side fell a little subsequently to the left); immobility of the globe of the eye; mouth half open-

* Ollivier, tom. ii. p. 511.

tongue covered with arterial blood, and occasionally protruded, but without permanent deviation of its point; lips covered with frothy saliva; no perceptible tension of the mouth.

Respiratory movements frequent, irregular, accompanied occasionally with *stertor*, and almost continually with a sound similar to that which is frequent in attacks of epilepsy. The alæ nasi contract convulsively with the muscles of respiration; twice there was violent sneezing, during which the patient, who lay on his back, bent forward. The limbs in a state of rigidity, which is easily overcome. This contraction, besides, is not entirely permanent; it ceases for some moments, and then the limbs are pliant enough, particularly the arm of the right side; the contraction then manifested itself suddenly, and lasted some time. In a word, these contractions seemed to hold a medium between tonic and clonic convulsions, though they approached nearer to the latter. The contraction of the muscles of the neck was not strong enough to prevent the head, in obedience to the laws of gravity, from inclining to the right or to the left, forwards or backwards, according to the position given to the patient. With respect to the sensibility, it was hard to determine whether it was abolished or not. There was observed a convulsive movement of the right arm, when its skin was pinched, and a similar movement when the integuments were cut in bleeding him. Were these movements owing to pain experienced by the patient?

In considering the almost convulsive contractions of the limbs, during which the arms were rotated inwards, and the strongly-flexed state of the thumbs, and the froth with which the mouth was covered, one would have thought it a fit of epilepsy; but the patient never presented any other symptom of this disease. He died five hours after the first appearance of the disease. He was not observed for the last two hours. On examining the body, the pons Varolii was found changed into a pouch, filled with blood partly coagulated, and mixed with some fragments of nervous substance, softened and colored by this liquid. This effusion made its way laterally by a small opening, but the principal rupture existed in the fourth ventricle, the floor of which, divided transversely, had given issue to the blood which distended the parietes of this ventricle.

It is to be regretted that this patient was not watched closely up to the time he died, because the general paralysis which must have preceded it might have been ascertained. It cannot be doubted but that the spontaneous hemorrhage produced the cessation of motion and sensibility when it occasioned the laceration of the entire substance of the spinal bulb. But if this case be incomplete in this respect, it is still very important, in its establishing the diagnosis of the effusion from its commencement in this portion of the cerebro-spinal system. These symptoms are truly characteristic, and present no analogy to those which are peculiar to other cerebral hemorrhages. I have since had several opportunities of observing this apoplexy at the moment of the attack, and I have always remarked convulsive contractions in the upper extremities with alternating movements of rotation inwards. The opening of the mouth underwent no change. These spasmodic convulsions, observed at the commencement of the attacks of apoplexy in general, seem to me to depend on the irritation which the blood produces on the extremities of the torn medullary fibres, with which it remains in contact, and on which it must act as an irritant.

With respect to the general paralysis of the upper and lower extremities, it has been uniformly observed in all cases where, at the *post-mortem*, there has been found an apoplectic cavity in the substance of the protuberance and peduncles. M. Serres saw several instances of this hemorrhage, and always, he says, complete immobility of the trunk and upper and lower extremities took place at the same moment when the apoplectic attack showed itself. Thus I hesitate not to assert, that paralysis existed during the last hours before the death of the person who is the subject of the preceding case.

In the first moments we saw that the respiratory movements were executed freely enough, and were even voluntary, since the patient sneezed twice, in doing which he flexed the trunk forwards, and we know that this movement of respiration requires an effort of expulsion which is impossible when the action of the respiratory nerves is abolished. It is probable that the hemorrhage, confined to the protuberance, and to some fibres of the corresponding portion of the peduncles, did but lacerate them progressively, whilst it extended itself towards the cephalic bulb, a point where the rupture was soon followed by death. The manifest movements made by the patient when pinched, and when his skin was cut in venesection, show that at the commencement the sensibility was not extinguished; and this circumstance is precisely conformable to the seat of the hemorrhage, when it first occupied, as we have seen, only the anterior fasciculi of the spinal marrow.

Death is so much the more rapid, according as the hemorrhage is more abundant and the more it involves the cephalic bulb of the spinal marrow. The respiration becomes more difficult and stertorous also; it becomes progressively retarded, and the patient dies of real asphyxia; sometimes, too, the lungs are found emphysematous. M. Serres quotes two facts which prove that life may still continue a long time, notwithstanding the paralysis of the upper and lower extremities, consecutive on hemorrhage of the protuberance. He met in

two subjects, even in the midst of the pons Varolii, a cavity containing a yellowish fluid; there was an induration of the surrounding cerebral substance. The numerous excoriations on the posterior parts of the body in both subjects, evident marks of a long-continued lying on those parts; the atrophy of the upper and lower extremities, equal on both sides, were evident proofs of a paralysis of long standing, consecutive on the effusion into the protuberance, which was partly absorbed.

Case 56.—A gentleman, aged 37, had been for several months in bad health, being affected with occasional tightness of the chest and difficulty of breathing. He had also severe dyspeptic complaints, with occasional vomiting, and yellow tinge of the skin, and considerable uneasiness in the region of the liver. For these complaints he had been advised by his medical attendants in the north to go to Cheltenham, and arrived in Edinburgh with that intention on the 22d March, 1828. I saw him on the following day with Mr. Wishart. We found his pulse frequent; his countenance sallow, and his expression febrile and anxious. He complained chiefly of tightness across his chest, with some pain in the region of the liver. Respiration was very imperfect along the right side of the thorax, and there was some œdema of the legs. By topical bleeding, purging, &c., he was considerably relieved; and on the 24th, he expressed himself as feeling much better, but his pulse continued frequent. On the morning of the 25th he was suddenly seized with giddiness, noise and confusion in his head, and numbness of the whole right side. He was oppressed, but not comatose; answered questions distinctly, but in a loud voice, and with a peculiar manner. He complained chiefly of noise in his head, of a tight and cramped feeling of his right arm and leg, with much pricking and loss of command of the parts; but when desired to grasp another person's hand with his, the muscular power did not seem to be diminished. The expression of his countenance was vacant and fatuous; the eye was natural. The face was slightly distorted, and the speech was in some degree embarrassed. The pulse was 120.

After blood-letting and the other usual remedies, the symptoms gradually assumed a more favorable aspect, and, after four or five days, he was considered as being out of any immediate danger, though the effects of the attack were by no means removed. His pulse was now natural, his speech was distinct, and his mind entire; his sight was good, and the appearance of the eye natural, except a slight degree of paralysis of the upper eyelid of the right side. His breathing was easy, and he made no complaint, except of the tight and cramped feeling, with numbness of the right arm and leg. His look, however, continued vacant and peculiar. His appetite and digestion were good, and his bowels easily regulated. He was improving in strength, and was able to be out of bed part of the day. This favorable state continued till the 14th of April, on which day he was found with a very frequent pulse, without any other change in the symptoms. This febrile state continued on the two following days with rapid failure of strength, and he died on the evening of the 16th. He continued sensible to the last, and during this febrile attack he seemed to have acquired an increased command over the limbs of the affected side.

About the commencement of his illness, on the 25th March, he complained of considerable uneasiness in passing his urine; for a day or two it was bloody, and there was a good deal of tenderness in the region of the bladder. After a few days this subsided, and he began to pass considerable quantities of puriform fluid of remarkable fetor, which subsided to the bottom of the chamber-pot after the urine had stood for a short time. This continued during the remainder of his life, though it had greatly diminished in quantity for several days preceding the last febrile attack. The urine was in sufficient quantity, and passed without difficulty.

Inspection.—The brain and cerebellum were found in every respect in the most healthy state, and no vestige of disease was discovered until the cerebellum was separated from the tuber annulare. In doing so, a cavity was exposed about the size of a large hazelnut, lined by a soft cyst, and full of dark grumous blood of a firm consistence. This remarkable cavity was formed partly in the substance of the tuber and partly betwixt it and the base of the cerebellum. It was decidedly more to the left side than the right, and the surrounding substance was softened, and tinged with dark red points, as if from injection of dark blood. There was effusion in the thorax to the amount of at least lb. ij. The right lung was contracted, and extensively hepatized; the left was much loaded with sero-purulent fluid. The liver was very considerably enlarged, and of a pale ash color and granular texture. The left kidney was pale, indurated, and tubercular. The inner surface of the bladder was deeply injected, and in several places showed distinct round ulcers about a quarter of an inch in diameter.

Effusion into, or on to, the crus cerebri will produce paralysis of the extremities on the opposite side of the body, and often of the opposite eye, from its affecting the optic nerve, without interfering with the sensorium.

The following case, though happily we have no *post-mortem* examination to produce in confirmation of the opinion, is most probably of this kind. It shows also the value of temperate and judicious treatment.

Case 57.—May 12th, 1847.—Mr. W., æt. 50, called upon me in the evening, complaining that he had lost the use of his right side. I found that the paralysis, though not complete, was unequivocal; he was able to move his arm and leg but very imperfectly, and complained of slight numbness.

History.—I learnt from him, that for some time past he has all day been occupied in a government office, after which he was engaged till ten at night in further mental labor. At this time he generally sat down to enjoy himself, frequently taking three or four glasses of brandy and water before going to bed, which was seldom before twelve o'clock. He has occasionally suffered from dyspepsia, and within the last two days has had two attacks of bilious vomiting, but had not previously applied for medical advice. He states that he has suffered from headache during the last few days, which was confined almost entirely to the right side. His intellect is quite perfect; the left pupil is dilated; pulse deficient in power, and irregular both in force and frequency. His first feeling of illness was an inability to walk as strong and as well as usual. This he experienced about three days ago. His speech is not affected, and he protrudes his tongue quite straight; there is a very slight appearance to dragging of the right side of the face; he complains of severe pain shooting down the right side of the face; head rather hot.

Ordered—Calomel gr. iiij. 4tis. horæ. Hirudines xx. dextri. lat. cup. Emp. Lyttæ nuchæ.

May 13th, 2 P.M.—Has passed a tolerable night, slept at intervals; bowels opened, rather purged; thinks that he has rather more numbness of the left leg; this was decidedly increased on his attempting to get out of bed, but is less numb now than it was an hour ago; finds his head easier when placed high; cannot incline it at all to the left side; is more comfortable while lying on the right side: states that the leeches relieved his pain, but he thinks that they made him feel more stupid; pulse same as yesterday.

Ordered—℞.—Inf. Buchu ℥i. Liq. Hyd. Bichlor. ʒi. Tinct. Lyttæ ♏x. sextis. hor. sum. Hirud. rept. Blister dressed with strong mercurial ointment, cold lotion to the head. Calomel omitted.

14th.—Has passed a quiet, comfortable night; says he is much better; says he is free from *pain* in his head, but that he still suffers from a sense of weight and difficulty of moving it off the pillow.

Bowels not open to-day; urine high colored.

The left pupil is still slightly more dilated than the right, but it acts quite naturally to the light. The right eyelid is œdematous, from the irritation of the blister. He can move his arm and leg perfectly. The numbness has quite passed away; pulse 18–20, soft and regular; mouth tender.

Pil. aloes co. gr. x. adde. potas. acet. ʒfs. singulæ dosi misturæ.

15th.—Better; can retain his water; head free from pain, but feels light. Mouth sore, pulse 76, regular.

19th.—Better; allowed to get up for a short time during the day. Countenance cheerful and natural; pulse soft and quiet; pupil of the left eye still a little larger than the right; boil on one of the leech bites.

24th.—Both pupils nearly alike; all symptoms of paralysis have disappeared, but he has a true carbuncle on the upper part of the forehead, on the seat of oue of the leech bites. Incised the carbuncle.

Ordered—Decoct. Sarsa. lbfs. Ext. ejus. ʒj. bis in die—allowed a glass of bitter ale with his dinner.

26th.—Carbuncle spreading; but in other respeets well; no headache; thinks the ale agrees with him. Incised the carbuncle again.

28th.—Much better; the carbuncle diminished in size; sloughing stopped. In other respects quite well. Gave him leave to go down to the Isle of Wight.

Remarks.—Whatever may have been the seat of the effusion, the case is one of great practical interest. In the first place, it shows the value of early attention to any symptoms of paralysis. It was a case which required great caution iu the employment of blood-letting. I doubt if he would have recovered without some; but I am quite sure if it had beeu pushed further, he would have had either delirium tremens or sunk exhausted. The appearance of the carbuncle shows that he would not have borne depletion. I believe that mercury here, as in all apoplectic cases, was invaluable; it arrested inflammation, and it promoted the absorption of the clot. With regard to the cause of the disease, I believe that may be sought alone in the over-mental exertion with which he taxed himself; there was no indication of diseased heart: of the exact condition of the cerebral arteries we were of course ignorant—there was no general plethora, or physical conformation, tending to the disease, such as short, thick neck.

Lesions of the Corpus Striatum.—I believe it is an invariable fact that extravasation into the corpus striatum is followed by paralysis; and consequently that there is no portion of the brain that *pathology* has so clearly indicated the function of, as the corpus striatum, in so far as its connection with volition and the production of voluntary motion is considered. Morgagni, with his usual acumen, was among the first to observe that disease or injury from extravasation into the substance of this body was followed by paralysis. In the eleventh letter of this writer, we find the following passage: "But whatever was the cause of this separation of the corpus striatum, I have already shown you, in the third letter which I sent you, how often a hemiplegia is wont to happen from an injury in one or other of these bodies or their neighborhood. Add to this what the sepulchretum teaches, that Willis also having sometimes examined the bodies of those who died after a long palsy, and a very grievous resolution of the nerves, had always found these bodies less firm than others in the brain, being discolored like lees of oil, and having their striæ greatly obliterated." But I think it will appear, from several facts I shall bring forward hereafter, that some physiologists have advanced too rapidly in theory when they assigned to this body the office of conducting and producing the action of the muscles of the lower extremities, while the thalamus presides over and superintends those of the upper.

Andral, in referring to this subject, makes the following judicious remark: "Among the cases of softening which we have detailed, there are several which seem to us to form a strong objection to the opinion of those who thought they had discovered in the brain the particular parts which preside over the motions of the upper and lower extremities. Very probably these particular parts do exist, since each limb may be separately convulsed, paralyzed, &c.; but it appears to us that these particular parts are yet to be found out, and we know nothing which can be so fatal to the sound doctrine of the localization of the cerebral functions as those premature localizations which some persons have been inclined to establish in latter times."

In opposition to what has been said of the special function of the corpus striatum as presiding over the motions of the lower extremity, the succeeding case may be quoted, in which lesion of the part in question was accompanied with paralysis not of the *lower* but of the *upper* extremity.*

Case 58.—*Effusion of blood into the corpus striatum of the right side; sudden loss of consciousness; hemiplegia on the left; death on the fifteenth day.*—A woman, 48 years old, addicted to wine, fell suddenly deprived of consciousness on the 16th of March, 1823. A little time after, she was bled; at the end of two hours she came to herself; she entered the hospital of La Charité the same evening. On the next morning we found the two extremities of the left side completely deprived of motion and sensation. The right commissure of the lips was drawn upwards; intellect perfect: pulse hard, vibrating, a little frequent. (She had blisters to the legs, and purgatives.) On the following day a visible amendment; sensibility restored in the paralyzed side; the left lower extremity begins to perform some movements; the left upper extremity as much paralyzed as on the preceding day. The 19th, she moves the leg and thigh of the left side with ease; pulse not frequent. (A blister between the shoulders.) From this period to the 1st of April, symptoms of gastro-intestinal irritation manifested themselves; tongue red and dry; great thirst; tension of the abdomen; diar-

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* Andral, op. cit., p. 102.

rhœa; delirium soon came on; the patient died in what is called the adynamic state. The paralysis of the lower extremity of the left side had been completely removed; not so that of the upper.

Post-mortem examination.—Cranium.—The only lesion presented by the encephalon was in the right corpus striatum. Towards the middle part of this substance, some lines beneath its upper surface, was found a small cavity filled with blood. Around them the cerebral pulp was very soft for the space of three or four lines.

Thorax.—Hypertrophy of the walls of the left ventricle of the heart, with contraction of its cavity.

Abdomen.—Gastric mucous membrane very soft and red through the entire splenic portion. Intense redness, and, as it were, granular appearance of the inner surface of the ileum through a great portion of its extent.

Remarks.—It is rare to find hæmorrhage so exactly limited to the corpus striatum as in the above case. The commencement of the affection was similar to that of the generality of cerebral hæmorrhages, whatever be their seat. The sanguineous effusion being inconsiderable, the patient soon recovered the use of her senses, and her intelligence continued quite perfect, which in this case may be referred to the seat of the hæmorrhage, the effusion having taken place far from the substance of the convolutions. At first the two extremities of the side opposite to that of the sanguineous effusion were equally paralyzed, which already invalidates the opinion according to which isolated lesions of the corpus striatum should modify motion only in the inferior extremity. But this is not all; one of the paralyzed limbs soon recovers the power of moving, and that is the lower extremity; that is to say, the limb which, according to the opinion just now mentioned, should alone have continued deprived of motion. Thus, the more we advance the more will facts tend to destroy, or at least to stagger, assertions too hastily made. There was no appearance in this case of any curative process having been set up around the hæmorrhagic cavity. The most alarming cerebral symptoms had, however, ceased, and it was under a complication of gastro intestinal inflammation that the patient sank. She had also hypertrophy of the heart.

The following case appears to prove that the tract of neurine which conveys the dictates of the will to the lower extremities as well as that which leads it to the upper extremities, partly passes through the corpus striatum; it also teaches us that partial recovery occasionally takes place after apoplexy.

Case 59.—*Traces of an old effusion of blood into the right corpus striatum; hemiplegia, preceded by loss of consciousness: death thirteen months after the attack of apoplexy.**—A hairdresser, 46 years of age, entered La Charité the 27th of January, 1822. He told us, that on the 21st of February, 1821, he had had an attack of apoplexy, during which he said he had entirely lost all consciousness. On coming to himself he was paralyzed in the two extremities of the left side. By degrees this paralysis diminished, and when we saw him he merely felt some debility in the left extremities. The arm of this side appeared to him not so strong as the other, and in walking he dragged the leg a little. He presented all the signs of pulmonary phthisis, of which he died, the 14th day of April, 1822.

Post-mortem examination.—In the posterior part of the right corpus striatum, nearer its external than its internal part, about an inch and a half below its upper surface, a cavity was found, an inch in length and an inch and a half in breadth. It was filled with a substance similar in color and consistence to thick chocolate. No false membrane extended over the parietes of this cavity. Around it, for the extent of about half an inch, the substance of the corpus striatum was transformed into a yellowish pulp. Caverns and tubercles in the lungs; heart normal; ulceration in the intestines.

Remarks.—Here again the lesion was confined to the corpus striatum, and still there was hemiplegia. Observe, however, that it was in the posterior part of the corpus striatum that the hæmorrhage took place. The paralysis, though considerably diminished, existed however, in a slight degree, at the time of death. We saw what was the state of the corpus striatum after the lapse of more than a year since the hæmorrhage. There was yet no organized membrane on the parietes of the cavity, and around it the cerebral substance had neither the natural consistence nor color.

Thalamus Nervi Optici.—Extravasation into the thalamus nervi optici is not accompanied by any unequivocal lesion of sensibility, as might be supposed if the theory that it is the ganglion of the sensory column were

* Andral, p. 103.

correct. It is indeed true that morbid anatomy has not yet shed any clear light on the functions of this part, beyond the facts that volition appears to flow through it; for it is seldom injured without paralysis of some part or other being the result. If it is in any way connected with the phenomena of sensation, as its communication with the posterior columns would induce us to believe, it is not entirely devoted to this purpose, for there are many cases on record, in which its lesions have been accompanied with paralysis, while the sensibility of the parts paralyzed has remained intact. In truth, I believe with Andral,* that though sensation is perhaps more frequently affected by cerebral hæmorrhage than motion, "it has been impossible up to the present time to detect, in the nature or in the seat of the alterations of the brain, the cause which sometimes suffers sensibility to be intact, and sometimes occasions its more or less complete abolition."

In the following case† the lesion was so entirely confined to the thalami that it cannot but prove interesting.

Case 60.—A man, 60 years of age, was admitted, towards the commencement of November, into the Maison de Santé, with a disease of the heart of long standing. The two extremities of the left side were also paralyzed; the intelligence was perfect. About three weeks before his admission, he told us that he felt his left leg fail him, and he fell, not however deprived of consciousness. A little after, he found the upper extremity of the left side also deprived of motion; the sensibility of the paralyzed limbs remained. His dyspnœa increased, as also his dropsy, and he died on the 25th of November, the hemiplegia continuing to the last moment.

Post-mortem examination.—In the centre of the right optic thalamus there was found a cavity filled with black blood of some consistence. The cavity was capable of containing a large cherry.

Thorax.—Lungs infarcted; hypertrophy of the parietes of the heart and dilatation of its cavities, which were filled with blood; cartilaginous incrustation at the base of the mitral valve; serous effusion into the left pleura; close adhesions between the heart and pericardium. Two bony concretions developed between this membrane and the proper substance of the heart.

Abdomen.—Considerable injection of the intestinal mucous membrane in different parts; spleen very large, dense, and black; liver gorged with blood.

Remarks.—This case differs from all the preceding, in this, that no loss of consciousness occurred when the hæmorrhage came on. The two extremities of the left side were equally affected with paralysis, though the lesion existed but in one optic thalamus.

From the corpora striata and thalami, we may proceed to consider those cases of effusion where the blood is confined to the tubular substance of the hemispheres. It is in these cases that we find, after the first effect of the effusion is passed, that the intellect remains intact, or only slightly disturbed. I have selected the following case from Andral in illustration. It also demonstrates the way in which a false membrane is sometimes thrown round a clot of blood.‡

Case 61.—*Effusion of blood into the middle part of the right hemisphere. Some softening of the cerebral substance around this effusion. Death the seventh month.*—A periwig-maker, seventy-one years of age, of a good constitution, fell suddenly, deprived of consciousness, on the 15th of May, 1820. This loss of consciousness lasted but for some hours. When he came to himself, he found that he was paralyzed in all the left side of the body. He entered La Charité, June 28, and presented the following state:—Pain towards the summit of the head, particularly on the right side; sight and hearing weaker on the left than on the right; left buccal commissure immovable, the right drawn out; tongue inclined to the left side; complete loss of motion in the upper and lower extremities of the left side; sensibility of these same members very much impaired, but not quite extinct; obstinate constipation;

* Andral, p. 103. † Ibid., p. 113. ‡ Ibid., op cit., p. 100.

pulse full, a little frequent; intellect perfect. On the 4th of July, it was observed that the left side of the thoracic parietes was covered with an enormous anthrax. A crucial incision was made into it a considerable depth; whitish eschars were detached from it by degrees; towards the end of August it was scarcely cicatrized. During the month of September another anthrax, still larger than the former, appeared in the supra-spinous fossa of the left scapula. Other small ones appeared in succession in the vicinity of this latter one, always on the left. At this time, the paralyzed limb became atrophied, and permanently contracted, the forearm on the arm, and the leg on the thigh. He complained when we attempted to move his limbs. He passed his urine and fæces involuntarily. Towards the month of October he became very feeble; scarcely ever spoke; large eschars formed on the sacrum; the contraction of the left upper extremity ceased, whilst its immobility remained. He died the 21st of November, without his respiration having become stertorous.

Post-mortem.—Complete marasmus; extremities rigid; broad ulcers on sacrum and trochanters.

Cranium.—Its walls very brittle; dura mater strongly adherent to the vault of the cranium; arachnoid of the convexity a little opaque; right hemisphere of the brain presented a cavity capable of containing a middle-sized apple; this cavity at an equal distance from the two extremities of the hemispheres, near the circumvolutions of the upper surface, external, superior and posterior to the corpus striatum. Its parietes were lined by a cellular membrane, dense, very resisting, in the tissue of which numerous vessels were ramified. By its inner surface, this membrane adhered closely to the cerebral substance, which is removed along with it. The cavity is filled with a softish substance having the color of iron rust. The surrounding cerebral substance is softened to the extent of four or five lines. The softened portion has a slightly yellow tinge. Some little serum in the ventricles and at the base.

Extravasations on the surface of the brain have sometimes been described as *meningeal apoplexy.* This is divisible into two kinds, one into the cavity of the arachnoid, the other into the sub-arachnoid tissue. Effusion in the arachnoid cavity is never the result of such a decided rupture of the vessels, as is visible to the naked eye, and hence it has been called an exhalation; but wherever there are blood-discs extravasated, there are also openings in the sides of the vessels. The blood coagulates in this situation, and is frequently invested with a false membrane, which adheres to the arachnoid. This subject has been well investigated by the French writers, Rostan, Bayle, Cruveilhier, Durant Fardel, and Dr. Pruss. There is a good abstract of the paper* of this last-mentioned author in the British and Foreign Quarterly Medical Review.

The disease has been described by Carswell and Dr. Burrowes in the Croonian Lectures, and more lately by Mr. Prescott Hewett, in the tenth volume of the Medico-Chirurgical Transactions. This careful pathologist brings forward many good instances of the investment of the coagula with a false membrane. He says, "The pathological investigations carried on within the last few years by Messrs. Longet, Baillarger, Calmeil, Ernest Boudet, and others, have all shown that the fine, delicate membrane which covers these extravasations of blood, and which presents to the naked eye all the characters of a serous tissue, is a newly-formed membrane, so beautifully adapted to the original serous membrane, that it is only with the utmost care that the exact limits of each can be defined. The cases of this nature which I have examined have afforded me an opportunity of verifying the accuracy of this opinion; and in speaking of the formation of this membrane, I shall bring forward several examples, which will, I trust, prove that it is much more frequently and much more rapidly formed than is usually supposed."

* Mémoire de l'Académie Royale de Médecine, tome xi. Paris, 1845.

Mr. Hewett considers that this membrane is wholly formed by the coagulated fibrine of the extravasated blood, not by a secretion of lymph.

Pain in the head always marks this form of apoplexy.

Paralysis follows this effusion, though not so invariably as that into the cerebral substance. One of the most important occasional characteristics of this disease is the intermission of the symptoms, and the consequent masking of the disease. The following case from Mr. Hewett is very instructive, though I cannot help saying that I think the existence of the mental excitement ought to have warned the practitioner as to the possible nature of the case, and forbade the use of quinine.

Case 62.—In the early part of 1841, Mrs. ———, æt. 65, after having for several days suffered from great mental excitement, was suddenly seized with violent pain confined to the right eyebrow, which lasted for two or three hours, and then disappeared. This pain continued for several days to recur twice in the twenty-four hours, presenting all the characters of brow ague; it was apparently relieved by quinine, but it was followed by a train of low symptoms, accompanied by a dry brown tongue, wandering and impairment of the intellectual faculties, terminating in coma. There never was any paralysis, neither were any contractions of the limbs observed. The patient died twelve days after the first attack of pain.

The body was examined about twenty-four hours after death. The veins of the scalp were gorged with blood. The dura mater, on the right side, appeared to be somewhat thicker than natural. A large quantity of blood was found extravasated in the cavity of the arachnoid; it corresponded both to the upper and to the inferior surfaces of the right hemisphere, and a small quantity of it had even made its way into the corresponding cerebellic fossa, where it was lying on the margin of the foramen magnum; the whole of this extravasated blood was of a dark fawn color. At the base of the skull, the extravasation at first sight appeared to have taken place between the dura mater and its arachnoid lining, for the blood was covered by a thin, smooth, and polished membrane, presenting to the naked eye all the characters of the serous tissue, with which it was perfectly continuous, at the margins of the extravasation; but this membrane, and the clot, were easily removed, and the arachnoid was then found slightly roughened, but uninterrupted throughout in its continuity. The substance of the brain was healthy, but its ventricles contained some fluid. The source of the hæmorrhage was not discovered. No marks of external violence existed about the cranium.

This form of apoplexy is not so invariably fatal as that into the sub-arachnoid tissue. Its duration is certainly longer; Dr. Prus says that it may extend a month, and upwards, and as a proof that recovery does sometimes take place, cites the discovery of cysts in the serous cavity. I was present at the inspection of a case of this kind at Bethlem, April, 1842. The patient had had symptoms of an apoplectic seizure two years previous to his death, from which he recovered. On the internal surface of the parietal, or reflected portion of the arachnoid, there was a false membrane of a brown yellowish color, about as thick as a piece of stout writing paper, near the mesial line, but gradually diminishing in thickness to that of a mere cobweb, at the base of the skull. The visceral arachnoid was thick and milky, the cerebro-spinal fluid abundant beneath.

The symptoms which mark extravasation on the surface of the brain into the sub-arachnoid tissue depend very much on the seat and rapidity of the effusion. When injuries of the skull give rise to effusion of blood, I oftentimes remarked that, as long as the blood was confined to the base of the brain, the mind was little affected, but as the blood rose upwards and reached the upper part of the hemispheres, that then coma and insensibility would come on. The proof, that the effusion com-

menced at the base, was the discovery of the ruptured vessel, generally the middle meningeal artery. I have not had the opportunity of observing whether the same applies to apoplectic effusion, but I can see no reason to doubt it. Hemiplegia seldom follows this form of effusion, and this most probably arises from the blood being poured into the cavity of the cerebro-spinal fluid, which readily makes way for it.

Dr. Prus sets down the cephalalgia, redness, and heat of the integuments of the face, as premonitory symptoms, rather than evidences of the actual occurrence of the hæmorrhage. I do not agree with him, as I am convinced that in many cases the hæmorrhage goes on very slowly at first. It is very true, as stated by this author, that the intellectual faculties are scarcely ever *perverted*, but weakened. The reason is, that the hemispherical ganglion is not usually *inflamed* in these cases, it is only *compressed*, and hence the most constant effect is coma.

Apoplectic effusions on the surface generally arise from the rupture of small vessels: sometimes no rupture whatever can be found, and sometimes they are the consequence of ulceration. When the effusion takes place slowly, the pain experienced is excessive, it is excruciating, there is blood enough to irritate the membranes and elicit that sensibility which, like the peculiar sensibility of every tissue, is a warning, protective sensibility, but not enough to smother the instrument whose office it is to receive impressions and recognize pain. Sometimes this suffering may last for some days, but generally coma comes on rapidly and relieves the pain. One of the most striking cases I ever saw of this kind, occurred in the person of an old servant. On the morning she was about to quit the service of a family where she had lived many years most happily, she awoke with severe pain in the head; she got up, and attempted to pack her boxes, and do other little things as usual, but she soon felt too ill to do anything, and she was obliged to go to bed again. Medical treatment had no power over the attack, and she died comatose on the fifth day, without any appearance of hemiplegia. The only lesion discovered was an effusion of blood over the whole of the upper part of the brain; it was smeared with blood. No ruptured blood-vessel could be discovered.

The following case is peculiarly interesting and instructive, from the obscurity of its symptoms and the insidious character of its onset:—

Case 63.—*Sanguineous Apoplexy—very obscure symptoms.*—M. C——, æt. 38, pale, and of fair complexion, short stature, robust, energetic and muscular appearance, and of well-ordered habits, has been married, and has had five children, the last of whom is five months old. She was nursing at the time of seizure, on the evening of the 15th of November, having been perfectly well and active to the period of attack; she was suddenly, and without cognizable cause, seized with severe and repeated vomiting, with partial loss of consciousness.

I saw her about twenty minutes after the commencement of vomiting, and found her sitting in a chair; the pulse was very small and feeble, about 105; the surface of the body cool and clammy; the eyes natural in their appearance; the pupils perfectly sensible, and consciousness much restored. She knew every body and everything, but had some hesitation in replying to questions; but the answers were all perfectly correct; muscular power appeared very weak, but under control; she complained of headache, and said she felt very ill; retching continued very troublesome. The contents of the stomach having been previously expelled, small quantities of mucus were ejected. Bowels constipated.—Ordered to be put to bed, her head raised, and cold lotion applied; hot bottles to the feet and legs, Hyd. Chlorid. gr. viij. stat. Magn. Sulph. ℥fs. ex. aquæ Cinnamomi ℥ifs. post horam dimidiam.

Saw her again in forty minutes; had thrown up the powder and draught; pulse quite small and feeble; sensibility rather more obtuse; she still answered all questions correctly, and the pupils were sensible; but she took very little notice without cause to do so. Head to be shaved, and cold lotions applied; large mustard poultices to the scrobiculus cordis and calves of the legs. Calomel gr. v. 4^{ta} horâ. H. Salinus. post sing. dos.

I visited her again in three hours. Pulse, intellect, and other symptoms the same; the surface of the body had become warmer. She had had the mustard poultices on for about two hours; the skin was much inflamed under them; but when questioned, said they pained her only slightly. Muscular power and sensation very much depressed, though not paralyzed. Contin. gruel only, for sustenance.

16th.—Pulse rather rallied still small and weak; retching not quite so troublesome, but was still continuing, and the medicine had been ejected; head was still painful; pupils sensible, intellect obtuse, but her replies more correct; the mammæ were secreting, and the child was ordered to be put to the breast. A purgative enema administered immediately. Calomel gr. ij. $3^{tia.}$ horâ. Hs. Aper. $6^{tis.}$ horis. Blister to the scrobiculus cordis, and behind the ears. Continue the cold lotion to the head.

17th, *mane.*—Intellect rather more obtuse; other symptoms same as yesterday; bowels had been freely acted upon by the enema yesterday.—Cont. Cal. et Hs. Sal. Emp. Lyttæ capiti.

Vespere.—Consciousness and sensibility much more blunted and impaired; when excited to do so, answered questions, but irrationally; did not generally identify persons around her, and when questioned as to how she was, answered—Quite well; pupils still contract, but not so sensitive. When I saw the patient she was still asleep. Her manner was rational, and not peculiar; but when asked who Mr. W., her medical attendant, was, said he was somebody else—evidently did not know him. When left to herself, she soon dozed off again, from which state she was roused again with difficulty, though it was unaccompanied by stertor. When roused, she answered the inquiry how she was distinctly, though slowly; that she felt very well—that she had no pain anywhere. I examined the pupils before she awoke, and they then contracted decidedly and forcibly to the light; after she awoke, they also contracted to the light, though not so much, but both acted equally. The pulse was 100, and rather jerking, not very easily compressed, but still not giving the idea of much power. The head was rather hot, but not decidedly so. There were, in fact, no decided symptoms. However, taking into consideration the progress of the disease, and the fact that she was hourly getting more stupid and sleepy, and there was a jerking character of pulse, I thought it right to abstract a little blood from the arm, taking care to watch its effects. The blood flowed from a free opening, and the pulse, after the abstraction of three or four ounces, became a little feebler, but when there were six taken, it became slightly intermittent, and this became more decided. I stopped the bleeding, taking only seven ounces. She was a little more sensible after the bleeding, but the change was very slight. Ordered Hyd. Chlorid. gr. ij. tertia horâ. Hyd. Bichlorid. gr. ij. Syrup. Croci Tinct. Lyttæ ʒifs. aq. Menth. ℥viij. $6^{tam.}$ $part^{m.}$ omni horâ. ℞. Olei Tereb. ℥i. Tinct. Assafetid. ℥i. aq. ℥viij. fiat enema.

During the night, and after I left her, I understand she was a little more conscious, but it did not last long, for she sank about ten the next morning.

Post-mortem—44 hours.—*Head.*—Vessels of pia mater very full, arachnoid natural. Before removing the brain from the skull, we observed a slight sanguineous effusion extending over the upper surface of the anterior lobes, below and before, backwards, forming a very thin layer—a mere smearing of the brain. On removing the brain from the skull, I found the under part of the right anterior lobe so soft that it gave way to the finger, and when the brain was removed, we found the anterior portion of the corpus callosum also torn and evidently softened. The layer of effused blood was thicker between the two hemispheres than at the upper part, and was gradually thickened as we traced it from above downwards, round the front of the brain to the base; it evidently proceeded from a vessel which had given way close to the fissura Sylvii; in the substance of the brain opposite the fissure, there was a clot about the size of a hazelnut—the brain softened and discolored around it. This effusion had just penetrated the wall of the anterior cornu of the lateral ventricle, for in it there was a small quantity of liquid blood smearing its floor, also the posterior cornu; all the rest of the brain was healthy.

Chest.—Lungs sound. Concentric hypertrophy of left ventricle, with diminution of the cavity. The walls were double their normal thickness; the cavity about half its natural size. The aortic opening was narrow; and along the attached edges of the semilunar valves there was a slight, narrow, cartilaginous thickening, also some deposit of cartilaginous matter in the mitral valve. Right ventricle a little dilated. The rest of the viscera healthy.

This case was one of the most obscure I ever met with. There were

none of the ordinary signs of sanguineous apoplexy—no paralysis of either motion or sensation—no morbid impression on the retina—no stertor—no suffusion of the eyes, no congestion of the head—neither were there any signs of inflammation of the membranes of the brain or hemispherical ganglia. The condition of the patient seemed to point more to serous effusion at the base of the brain, and there was nothing in either the history of the case or appearance of the patient to make me regard it as asthenic in its character and the danger of the patient as imminent. I ventured on the abstraction of blood, and I am now sorry we did not carry it further.

The following case from Ducrot, (Essai sur la Céphalite, 1812, Obs. 2,) quoted by Lallemand, illustrates the progressive effects of extravasation of blood in exciting inflammatory action of the tubular substance, and with it convulsive movements; these being followed by paralysis, as the brain becomes softened, and the conducting instruments destroyed.

Case 64.—Mr. A., about 60 years of age, had a fracture with a depression into the left frontal region by a stone thrown with violence; he lost much blood, but was able to return home. The next day, throbbing pains came on, with confusion of memory and inability to give proper answers to questions; power of speech not much impaired, but incapability of putting the tongue out. The pulse was feeble; oppression. (A liquid emetic.) The third day deglutition difficult, thirst, skin hot, pulse frequent. The fourth day, drowsiness, answers always correct. (A large blister to the nape of the neck.) Fifth day, drowsiness increases, loss of speech: he understands what is said to him, but can only answer by cries; the fæces and urine pass involuntarily. Sixth day, drowsiness still more increased, symptoms the same. Seventh day, no alteration. Eighth day, delirium, loss of sense, convulsive motions of the trunk and limbs, with distortion of the mouth and eyes; he had attacks every quarter of an hour. In the interval respiration difficult, snoring, eye fixed, gaping mouth. The ninth, at midnight, the convulsions cease, the drowsiness diminishes, his senses return, but the alteration of memory and judgment continue; slight delirium, the left limbs begin to be paralyzed. The tenth, complete paralysis of these limbs, with rigidity and slight pain when they were raised from the trunk; the countenance idiotic, answers not correct, optical illusions, convulsive jerkings during the night. The following day same state. The eleventh day, loss of sense, aphonia, immobility and general insensibility, coma, respiration loud and difficult, &c.; death at eleven in the evening.

Autop. cadav.—Depression two lines in depth for about two inches on the frontal region. At the internal and posterior part of the right lobe of the brain, inflammation an inch and a half in extent from above to below, and half an inch in the other direction, extending on one side as far as the corpus callosum, and on the other to the base of the brain. This inflammation was marked with a bright redness, sprinkled as it were through the substance of the brain. The arachnoid, which covered the convexity of the brain, was opaque, white, very thick, and smeared upon its internal surface by a thin layer of albuminous matter.

Our attention may next be directed to the effect, and, consequently, the symptoms of apoplectic effusion on or into the *Cerebellum*. These lesions are always more or less followed by hemiplegia, and this is, I believe, invariably, as in the instance of brain, on the opposite side of the body. Sight and hearing are generally secondarily affected from the propinquity of the optic ganglia and auditory nerves.

In many cases, though not in all, we find decided disturbance, generally excitement of the generative organs.*

The following case is interesting in many points of view; first, it is an instance of a moral cause—fright so exciting the cerebral circulation as to give rise to effusion; secondly, the *gradual* loss of power, the effusion, in all probability, being very small; thirdly, the effect on the organs of vision; fourthly, the supervention of inflammation in the cerebellum, and its effect—convulsive movements; fifthly, the super-

vention of inflammation of the hemispherical ganglion and its effect—delirium; sixthly, effusion into the ventricles, and its effect—coma.

Case 65.—*Considerable softening of the right lobe of the cerebellum; with hemiplegia.**—A seamstress, thirty-one years old, who had hitherto enjoyed good health, about six weeks before entering the hospital of La Charité, had a fright whilst menstruating: the menses were suppressed, and, immediately after their disappearance, she was seized with dizziness, and an acute pain in the back part of the head, towards the right side. The dizziness disappeared after a bleeding, but the pain of head remained; it was unconnected with any other symptom for eight days; subsequently the patient began to experience an annoying sense of formication at the ends of the fingers of the left hand; she could use this hand but awkwardly, and was astonished at seeing what she handled with it fall continually from her grasp: she soon became unable to work with it at all; the entire arm seemed very heavy. After some time the lower extremity of the left side became weaker, and in about a month the patient had complete hemiplegia of the left side. At the same time that the patient thus lost the power of motion of one of the sides of the body, her sight, till then extremely good, became very weak, and five weeks after the invasion of the first symptoms, she became completely blind.

This was the state in which we first saw her; deprived of sight, and of the power of moving the limbs of the left side; the pain of head had then become less acute; the patient, however, still felt it, and referred it to the lower part of the occipital region of the right side.

The paralyzed limbs were flaccid, and could be moved in all directions; the skin covering them still retained its sensibility; no trace of paralysis of the face; the pupils, moderately dilated, still contracted on the sudden approach of light; the appearance of the eyes was natural; there was, however, all but complete blindness, the patient being scarcely able to distinguish day from night; the intellect was perfect, the pulse natural; the catamenia had not reappeared since they were suppressed by the fright. Leeches were first applied to the nape of the neck, then to the genital organs; aloëtic pills were frequently given, and subsequently the back of the head was covered with a blister.

No change appeared for the first three weeks of her stay in the hospital; then, without any known cause, the pain of head suddenly became more violent, and extended to the entire cranium; the extremities of the left side, which till then had remained entirely immovable, were several times agitated with convulsive movements, which were slight in the lower extremity, but very violent and almost continual in the upper limb; acute pains accompanied these convulsions; the intelligence soon became disturbed; complete delirium set in; for twenty-four hours the patient spoke, and was agitated incessantly; she then fell into a profound coma, in which state she died.

Post-mortem examination.—The pia mater extending over the convexity of the cerebral hemispheres was very much injected, as was also that covering the cerebellum. The substance of the brain, properly so called, was marked with a considerable number of red points, and presented no other lesion; lateral ventricles distended with a great quantity of limpid serum; the fornix and septum lucidum natural. Externally the cerebellum appeared healthy; but we had scarcely removed some layers of the substance of its right hemisphere, proceeding from above downwards, when we found an immense cavity, where this substance, deprived of its normal consistence, was changed into a grayish *bouillie;* this softening occupied at least two-thirds of the right hemisphere of the cerebellum; it partly implicated the prolongations which go from the cerebellum, either to the spinal marrow, or to the tubercula quadrigemina, or to the annular protuberance: it did not extend as far as the lower surface; in no part of its extent was there either injection or infiltration.

Case 66.—*Effusion of blood into the right hemisphere of the cerebellum; hemiplegia of the left side, accompanied with loss of consciousness. Death* 50 *hours after the appearance of the first apoplectic symptoms.*†—A female, 22 years of age, was treated at the hospital of La Charité for a chronic gastritis; she had evinced symptoms of this affection for the last two years. One evening at six o'clock, a short time after having eaten, and before going to bed, she fell, suddenly deprived of consciousness and motion. After about an hour she recovered the use of her senses, but could not move the extremities of the left side. On seeing her the next morning her state was as follows: face injected equally on both sides, contraction of the pupils, vision unimpaired, air of stupor; she answers questions with correctness, no embarrassment of speech. The two extremities of the left side completely deprived of voluntary motion; they presented no trace of contraction; sensibility of the skin covering them impaired. Pulse 75, and full; heat of skin natural; respiration hurried, 30 to 34 every minute.

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* Andral's Clinique Médicale, sect. ii. Case I. p. 202.

† Andral, op. cit., p. 195.

This girl seemed to us to have been struck with cerebral hæmorrhage; she was bled to sixteen ounces. This produced no amendment, and the symptoms going on from bad to worse, the patient expired on the evening of the day on which she was first seen.

Post-mortem examination.—Cranium.—Sub-arachnoid cellular tissue of the convexity of the cerebral hemispheres very much injected. The latter present no appreciable alteration, except considerable sandiness of their tissue. In the central part of the right hemisphere of the cerebellum was found an effusion of blood, which formed in the nervous substance a cavity large enough to hold a pullet's egg. Around this cavity the tissue of the cerebellum was red and softened for the space of three or four lines.

A man mentioned by Serres,* after a blow on the back and lateral part of the head, which stunned him at the time, had a certain unsteadiness in walking, which made him always anxious to take the arm of a friend; and he had a weakness of his head, which made him liable to be much affected by a small quantity of wine. This state continued about eighteen months, when he became low spirited and irritable, and was affected with trembling of the limbs. Soon after, the left leg became paralytic, and the arm of the same side felt benumbed and weakened. After the insertion of a seton in the neck, the arm recovered. Three months after this the patient died, with fever, delirium, and an affection of the bowels.

There was found disease in the right lobe of the cerebellum, with an abscess and extensive softening.

In another man, mentioned by the same writer, who died in forty days, there was palsy of the right leg, with wasting of the limb, but without loss of sensibility, the arm of the same side being little, if at all, affected.

There was found ramollissement of the left lobe of the cerebellum, occupying chiefly the centre of the left peduncle.

The cases above referred to prove that lesions of the cerebellum, like those of the cerebrum, generally produce paralysis of the side of the body opposite to the seat of injury. In some cases the sensibility was decidedly impaired, but in others this function scarcely presented any signs of implication.

One of the most interesting and extraordinary circumstances connected with injuries of the cerebellum with which I am acquainted, I give on the authority of Andral.†

"When the hæmorrhage of the cerebellum occurs simultaneously with that of the cerebrum, or a little time after it, but so that the blood is effused on the right into the cerebellum, and on the left into the cerebrum, or *vice versâ*, there is paralysis only on the side of the body opposite to the hemisphere of the brain where the hæmorrhage has taken place; that is, on the same side as the hæmorrhage of the cerebellum. How then does it come to pass, that whereas the movements of the extremities of the right side are abolished when there is an effusion of blood into the left hemisphere of the cerebrum, the effusion which takes place simultaneously into the right hemisphere of the cerebellum should no longer have the power of paralyzing the extremities of the left side? It had this power, however, in the cases where the cerebrum remained uninjured: is not that a fact worthy of attention?" Any comment upon this circumstance in the present state of our knowledge would be pre-

* Journal de Physiologie, 1822-23.

† Op. cit., Part I. p. 201.

mature. We would only beseech pathologists to pay particular attention to the fact, and in the first instance endeavor to ascertain whether matters invariably fall out as they are reported to have done in the cases related by the learned and very candid author above quoted.

Abercrombie* quotes a curious case from Morgagni, in which scirrhus of the left lobe of the cerebellum was followed by paralysis of the lower extremities, the upper being left perfectly sound.

Portal, when treating of paralysis produced by lesions of the cerebellum, says: "In some cases of injuries of the cerebellum, the paralysis and the convulsions have happened on the wounded, and not on the opposite side, as is usually the case in patients whose cerebrum has been wounded; but still this is not sufficiently proved to be received as a demonstrated point of doctrine."

Among the anomalous instances of disease of the cerebellum producing no symptoms of paralysis, I may relate one mentioned by Douglas.† The patient had been for three months affected with pain in the forehead, which generally obliged him to sit with his head leaning forward; he had little appetite, and his sleep was disturbed; but no other symptom of disease. He died suddenly from an attack resembling syncope, having been for a day much better, with a good appetite, and enjoying quiet sleep. An encysted abscess was found in the middle of the cerebellum, and a rupture of the left lateral sinus, which probably was the immediate cause of death.

I will conclude these observations on sanguineous apoplexy with a quotation from Dr. Bright's admirable work.

Dr. Bright‡ says: "When the decided attack has taken place, it varies greatly in extent and severity; sometimes it is attended with violent pain in the head; sometimes there is not the slightest pain; sometimes it assumes the form of complete apoplexy, the annihilation of all consciousness, the extinction of all sensation, the loss of all voluntary motion; for a few minutes, or a few hours, the retarded pulse bespeaks the difficulty with which the heart and arteries maintain, by their voluntary actions, the labor of circulation, and the stertorous sound of impeded breathing betrays the inactive condition of those muscular parts through which the involuntary powers are called upon to force the air in the process of respiration, and these soon prove insufficient to maintain life. At other times, the apoplectic condition, though well marked, gradually subsides, or frequently the state of insensibility continues for a few minutes only; while in some attacks the consciousness is never destroyed.

"But though the apoplectic state should not exist, or though the consciousness should have returned, yet, if effusion of blood have taken place, paralysis will generally remain. The extent of this paralysis will vary almost indefinitely; it frequently affects both the motion and the sensation of the same part; sometimes, however, the motion, and sometimes the sensation, suffers in the greatest degree; and, occasionally, the sensation of one part and the motion of another are more strikingly influenced.

"Hemiplegia is by far the most common form which paralysis assumes

* P. 470. † Quoted by Abercrombie, 129. ‡ Op. cit., p. 327.

from effusion of blood within the cranium. I have, indeed, never met with a decided instance of paraplegia from this cause; occasionally one leg or arm will be affected, without the other limb on the same side suffering materially; but those forms of paralysis which occupy, almost exclusively, the two upper or two lower extremities very rarely result from the sudden effusion of blood in the brain. Cases occur, where paralysis of the two lower extremities has appeared to depend on other disease or injury in the brain; but of these we should always be somewhat skeptical, from the obvious sources of error to which they are liable, amongst which the unobserved or the unsought diseases of the spinal cord and its membranes are the most to be suspected. Defective articulation and deglutition, either alone or as attendants upon hemiplegia, are likewise common results of apoplectic seizures. Occasionally great pain is experienced in the affected limbs, while at other times a sense of numbness alone is felt. The powers of the mind generally suffer in some degree, but this varies greatly; sometimes the mind evinces great irritability, and sometimes a childish tendency to excitement, and a trifling turn quite inconsistent with the former disposition, or with the present situation, of the sufferer: at other times, the patient falls into a dull state of imbecility—while cases occur in which the affection of the mind is so slight, that it is only by close examination it can be detected."

"The successive changes," says Dr. Bright,* "which take place in the effused blood, and in the portion of the brain injured by the effusion, will of course depend in a great degree upon the concomitant circumstances of the patient. In some cases no effort at repair or restoration will be made, but the surrounding parts will gradually soften down; and even though there is no tendency to continued hæmorrhage, the mischief will increase, till, some more extensive effusion occurring, the disease proves fatal. In other cases, the mingled mass of blood and comminuted brain will remain for many months, forming a soft mass, without there being apparently sufficient power in the constitution to produce either absorption or repair. In other cases, it seems as if all the injured portions of brain separated, and a smooth surface formed, with more or less vascularity, derived partly from the natural vessels of the brain, and partly from newly-formed vessels, and thus gradually a kind of cyst is generated as a lining to the cavity produced by the clot. Then a process of contraction and absorption goes on, till, according probably to the greater or less powers of the constitution and the admixture of cerebral matter with the blood effused, either a small quantity of watery fluid remains, and, this diminishing, the walls of the cavity at length coalesce, or a more solid yellowish-white substance interposes, forming a permanent cicatrix in the brain.

"The period of time which these different changes require for their completion seems to vary considerably. In a case which proved fatal on the sixth day, a commencement was already made; the greater part of the injured brain appeared to have separated from that which had suffered less; a smooth and polished surface presented itself on many parts of the cavity, and the natural vessels of the brain appeared to have

* Op. cit., p. 332.

become enlarged. In another case, on the tenth day the clot had undergone considerable change in its color, and with the broken cerebral matter was separating from the more sound brain. But in Case 138, though twelve days had elapsed, no such favorable change had taken place; the broken surface was still soft, and the surrounding brain was ready to yield on every side. In Case 140, where death occurred after twenty-three days, considerable change had taken place in the surface of the cavity; but in some parts the process by which the injured brain is detached was not completed. In Case 139 seven weeks had passed between the effusion and the death; and here a very distinct lining membrane had formed of an opaque white color, and so solid as to allow of being detached from the surrounding brain. In this case it was peculiar that this fine membrane should have formed, though the brain immediately exterior to it was decidedly unhealthy and discolored; but it is possible that this might in part have depended on subsequent mischief. In the same case a cavity was discovered of a date much prior, no doubt, to that I have been mentioning, containing a clear fluid, and lined with a fine membrane, the opposite surfaces of which were beginning to form vascular adhesions; and very similar cavities were found in the case of Saunders; but the date of these formations was likewise doubtful. In the case of one after a lapse of eleven months, the small cysts were formed of opaque white substance, and did not seem so far advanced as in Saunders. In case 145, after about a year, a cicatrix was formed, a little soft in the centre, but apparently contracted, round its whole circumference, and proceeding to the obliteration of the cavity. But in Case 144, after an equal period, the soft and disorganized mass still showed no tendency to undergo a favorable change."

In many cases it is extremely difficult to distinguish between apoplexy from congestion and epilepsy at the period of the attack. Dr. Bright* remarks on the "difficulty of drawing a correct diagnosis between apoplexy from congestion and certain epileptic attacks. There is in truth scarcely any precise distinction to be recognized; the same state of vessels apparently inducing both, and the one passing imperceptibly into the other. The convulsive nature of the symptoms marks the chief difference, and this probably depends rather on some original irritability of the brain, or on the part which chiefly suffers from congestion, than on difference of the exciting cause."

Serous Apoplexy.—Serous apoplexy, though not the result of any single condition of the vascular system of the brain, nevertheless is always more or less dependent on general debility, with local vascular excitement and congestion of an asthenic character. For instance, a man of intemperate habits may get a blow on his head, producing concussion; if this is judiciously treated, he recovers in the course of a few days. But suppose that he is bled largely from the arm, and purged freely, the accident being treated without reference to the habits and constitution of the patient, the result will almost certainly be serous apoplexy. On the other hand, suppose that he is stimulated, under the impression that he is sinking from exhaustion, then inflammation of the brain would ensue.

* Reports of Medical Cases, vol. ii. p. 198.

The exact treatment in such a case must, of course, depend on the state of the pulse, skin, head, intellect, bowels, &c., but most probably a purgative with a cold lotion to the head would be all that were required.

The most unequivocal cases of asthenic serous apoplexy are those which occur from suppresion of urine, the result of destructive disease of the kidneys. The following case is a good illustration of this form of the disease.

Case 67.—Frederic Smith, æt. 29, boot-blacker by trade, was admitted into St. Thomas's Hospital, January 25, 1842, under my care. On admission, he was suffering from suppurative erysipelas, of a low, slow, sluggish character. His countenance indicated organic disease. He complained of great pain in the bladder and inability to retain his urine for many minutes. The urine was pale, with a whitish sediment, and alkaline, albuminous, and containing phosphatic acid. This disease of the urinary organs was traced to an injury of the loins, received on board a ship, at the age of fourteen. Up to this time he had been a fine hearty boy; but from the period of the accident he suffered more or less from disease of these organs. On his admission, I ordered him Decoct. Pareiræ bravæ ℥ifs.; Acid. Muriat. dil. ♏x. Gin ℥iv. daily—beef-tea, fish. Two incisions and poultices to the limb; in a fortnight the erysipelatous inflammation was entirely subdued, and the wounds on the limb nearly healed. After a few more days, suppuration commenced suddenly in the opposite thigh; the following day, the 13th of February, this abscess was opened, and a large quantity of thin, ichorous discharge evacuated. From this day up to the second of April, about six weeks, the discharge varied a little from day to day, but never ceased altogether.

On this day, a little before midnight, a sudden change took place. He had been talking to his mother, quite rationally, and, as he seemed inclined to go to sleep, she left him to go to the fire, when he suddenly *screamed* out—Oh, mother, mother! what have you done to my head? and he continued screaming violently for four hours, that was until four in the morning; he then suddenly became quiet, and remained in one position until his death, which took place at 12 o'clock, that was exactly twelve hours from the seizure.

Sectio cadaveris.—Post-mortem—twenty-two hours.

Head.—Calvarium, natural; dura mater, idem. On removing the dura mater, we found, instead of the usual appearance of the pia mater, the whole surface of the brain presenting a pale yellow or whitish color, scarcely broken by even the larger vessels of the pia mater, which, instead of being distended with blood, contained only a narrow line in their centre. The smaller ones were quite empty. In three or four places there was a dotted appearance, caused by the effusion of blood in minute points, about the size of a pin's head This pallor of the brain was partly owing to the empty state of the vessels, and partly to a layer of serum containing a few flakes of lymph effused beneath the *tunica arachnoidea investiens.* This layer of serum was found in equal quantity at the base of the brain. Beneath the pia mater there was a small deposit of ill-formed curdy pus. This membrane separated very readily from the brain. *Cerebrum* not quite so firm as in health. *Cerebellum* softer than cerebrum. *Hemispherical ganglion* pale. Fibrous neurine beautifully bright and distinct; more fluid than usual in the ventricles.

The connection of the tenia semicircularis and anterior extremity of the peduncles of the pineal gland, with the anterior pillar of the fornix, was beautifully distinct, also the longitudinal fibres of the septum lucidum. Some imperfectly-formed pus in the pia mater, as it passed under the fornix to form the velum interpositum.

Thorax.—Pleural adhesions on the left side of old standing. Gray hepatization of the lower lobe of the same lung; a small abscess, about the size of a walnut, in the same. The rest of both lungs healthy; *no* tubercular deposit.

Abdomen.—Liver, nutmeg color, no tubercles, colon very low down, nearly in the pelvis; mesenteric glands large. Chyle vessels very distinct.

Right kidney.—Only about half the cortical substance remaining, and this presented the appearance described by Dr. Bright. The rest of the kidney was occupied with small cavities, lined by a distinct membrane, and containing more or less tuberculous matter. Renal pelvis enormously distended, and also the ureter, which resembled in appearance and size a portion of contracted small intestine. There was extensive tuberculous deposit in the coats of this tube, within half an inch of its termination in the bladder, which must have rendered it almost impervious.

Left kidney was entirely disorganized, not a fraction of its proper substance remaining; it consisted of cysts or cells of various sizes, lined by a membrane, the smaller containing tuberculous matter, and the larger thick serum, with flakes of lymph and pus. Ureter and pelvis natural size. Bladder contracted; lining membrane, dark grayish color, but not rough

or thickened; openings of the prostatic ducts extremely large, about the size of swan shot, or small peas. The right lobe of the prostate entirely disorganized, converted into a series of cells, communicating freely, about the size of peas; the left natural.

I have no doubt that severe mental exertion carried on in an exhausted system will sometimes lead to sudden serous effusion. In these cases very decided treatment is required to arrest it. Premonitory symptoms always exist in these cases, but they are not observed by unprofessional friends, and the medical attendant is frequently not called in until it is too late.

The following case, to which I was called by my colleague, Dr. Brodie Sewell, and which I give in his own words, illustrates what I mean; and though I have no *post-mortem* appearance to adduce in proof of the positive pathological condition in this case, I think no one will dispute the existence of serous effusion. My chief reasons for considering the attack inflammatory, though accompanied with great want of power, were, 1st. The exciting cause, excessive use of the organ, and therefore necessarily excessive sanguineous stimulation; 2d. The heat of the head. Nevertheless, if this patient had been bled to any extent in the first instance, he would have sunk immediately. The diffusible stimulus which was given was the best thing, and it kept the flame in until the mercury arrested the asthenic inflammatory action, and caused the absorption of the fluid.

Case 68.—J. B., æt. 20, of an excitable disposition, spare habit, ordinary good health, though suffering occasionally from severe headache, was seized on the 11th of November, 1844, under the following circumstances:—

He had for many weeks been studying very closely, without attention to the regularity of the animal functions; returning after a long abstinence to a hearty meal, and applying closely during the greater part of the night. He had not been to bed on the night of the 10th.

Complaining of headache after dinner on the 11th, he was persuaded to go out for a little time instead of reading. He left home for this purpose, and was brought back in about ten minutes by a gentleman, who saw him stagger and fall. He was then sufficiently sensible to state somewhat unconnectedly, that he had previously felt dizzy, and that he recollected falling. This amount of intelligence was, however, quickly annihilated, as, when I saw him, he was in a state of complete coma. The pulse scarcely perceptible, the extremities cold, and the pupils perfectly insensible to light. The breathing regular, without noise; no vomiting. I ordered him a mixture of ether and ammonia, with hot applications to the extremities.

Three hours afterwards, a slight reaction had taken place, there being fuller and quicker pulse; the extremities had recovered their natural temperature, but the symptoms of pressure on the brain still continued undiminished, and the head was very hot. I then ordered the head to be shaved, two leeches to be applied to the temples, and a blister to the neck, with three grains of calomel laid on the tongue every three hours.

Nov. 12.—No improvement has taken place; the patient lies in the same state; the blister rose without exciting any apparent sensation; he passed water once in the bed; no action of the bowels; the extremities become rapidly cold if exposed. This morning Mr. Solly saw him with me. He approved of the general plan of treatment, but thought it had not been carried out sufficiently.

Ordered gr. v. of Cal. every hour; cold application to the head. This was continued without intermission, until the morning of the 13th, when Mr. Solly saw him again. A slight improvement was evident; the pupils were somewhat contracted; he evinced impatience when the powder was placed in his mouth, and he swallowed a little beef-tea. The same treatment was continued, and, towards evening, he was more restless and uneasy, and became conscious of the soreness of his gums and neck; at least, he frequently raised his hands to his mouth, and moved his neck upon the pillow.

Nov. 14.—Mr. Solly saw him again with me, and pronounced him much better; slight consciousness of person and place; sight impaired, and eye wild, but pupil much more active. Gums touched, but no great amount of salivation. Calomel every four hours, and a dose of castor oil as the bowels had not acted. During the night of the 13th, first cognizant of desire to pass water.

Nov. 15.—Mr. Solly saw him for the last time; nearly all the symptoms of pressure having been removed. As most probably, however, some effusion might remain, he was ordered five minims of Tinct. Canth. in a mixture, with some Liq. potassæ. This was continued, with such modification as circumstances required, until he was perfectly convalescent; and he was able to resume his studies after the Christmas vacation.

Simple Apoplexy.—Dr. Abercrombie classifies under a distinct head, that of *simple apoplexy*, those cases which occur and terminate fatally, without leaving any morbid appearance in the brain. These cases are peculiarly interesting and instructive, but I think not so inexplicable as some have supposed. I quite agree with Dr. Burrowes in attributing the fatal result to pressure on the brain from distended vessels, brought on by determination of blood to the part, or by detention of blood there. "But, if this be the correct explanation of the production of these cases," says the same author, "why does the coma persist, and death so speedily ensue, although the vascular distention, the supposed cause of pressure, is removed by abstraction of blood, or other remedies, and, as we ascertain after death, the brain has sustained no structural lesion?"

He ascribes the fatal event to another cause. He considers that from the partial arrest of the respiratory function, the substance of the brain is gradually saturated with undecarbonized blood. The apoplectic person remains in a condition analogous to that of one whose rima glottidis is constricted, or who has been suffering from asphyxia for some time. The apoplectic patient dying, not simply from pressure on the brain, but from the effects of imperfect respiration, the presence of undecarbonized blood in the brain and other organs.

Even in those cases which terminate fatally, and serum or blood are found effused within the cranium, Dr. Burrows attributes the coma to the state of *congestion* which *precedes* the effusion, and not to the effusion itself. "I am of opinion, that apoplectic coma is rarely dependent upon the extravasation of blood, although the concomitant paralysis undoubtedly is. Upon the examination of the brains of apoplectic patients, we sometimes find large extravasations of blood, which, from peculiar appearances in the clot, we feel assured have existed there for many days, or even weeks, and yet, during the greater part of that period, there has been no coma. Upon other occasions we discover small extravasations of blood within the brain, which, from their appearance, we can decide have only been effused a short time prior to death, and, nevertheless, there has been a well-marked coma in these cases. Hence, if pressure be regarded as the physical cause of apoplectic coma, and that pressure is supposed to be occasioned by the extravasated blood, then we must account for the paradox of a small extravasation producing a coma which terminates fatally, and a large effusion of blood having no such effect."*

Dr. Alison† considers that the cause of *simple apoplexy* "is the pressure exerted on the brain by an increased propulsion of blood upon it, or transmission of blood through it."

The following case, for which I am indebted to Mr. Adams, Curator of the Museum at St. Thomas's Hospital, illustrates well the form of simple apoplexy, and it confirms the opinion that the symptoms arise from pressure, occasioned by turgid vessels.

* P. 92, op. cit. † P. 692.

Case 69.—James Bibby, æt. 38, a man of intemperate habits, though generally enjoying good health; for twenty-three years in the service of Mr. Whitfield. He had had two slight apoplectic fits; one about two years, and the other a few months, previous to his last illness. On the morning of the 7th December, 1845, he complained of fullness and pain in his head, and appeared dull and heavy; about 10 A. M. he suddenly fell down in a fit, his head came in contact with a piece of stone, by which the temporal artery was wounded, and he lost a large quantity of blood before any assistance was rendered; when picked up, he was perfectly insensible, with extremely labored and slightly stertorous breathing; he remained in this condition for about twenty minutes, when consciousness began to return, and he afterwards completely regained his senses; no paralysis followed this fit. A purgative dose of calomel and colocynth was given; head shaved, and counter irritation applied.

On the following day, the 8th December, he became restless and wandering, and was allowed a small quantity of gin.

On the 9th December, the restlessness and wandering were increased, and he became extremely violent; his symptoms resembling those of delirium tremens; gin, morphia, and ammonia, with sulphuric ether, were given. He continued in the same state till 6 P. M., when he suddenly became perfectly quiet, the pupils fixed, breathing stertorous, pulse slow, full, and labored, and had the ordinary appearance of a man in an apoplectic fit; in this condition he remained till 11 P. M., when he died; five hours from the appearance of the apoplectic symptoms.

At the *post-mortem* inspection, on the 10th December, the only morbid appearance found, was an *extremely* congested condition of the vessels of the membranes and substance of the brain, with a slight serous effusion beneath the arachnoid over either hemisphere. The thoracic and abdominal viscera were generally healthy.

Andral believes in the existence of this congestive apoplexy, and relates the following very interesting case, which also throws some light on the pathology of serous apoplexy:*—

Case 70.—A woman, fifty-one years old, of a sanguine temperament, and strong constitution, ceased to menstruate about her forty-ninth year; during the six months following she was subject to numbness in the right arm. In her fifty-first year she suddenly lost consciousness, fell, and retained, when she came to herself, some difficulty in her speech, with some falling of the commissure of the lips and tongue on the right side; considerable diminution of motion and sensation of this side, nausea and bilious vomiting. Under proper treatment this state disappeared at the end of four weeks. After this the patient returned to a perfect state of health, when, towards the middle of March, 1819, she again began to feel a little weakness in the right arm; slight pains of head in the frontal region soon supervened, and on the 20th of April, without any obvious cause, there came on in the night, during sleep, a new attack, more violent than the former, and of the same side, total loss of speech, considerable diminution of sensibility, but particularly of motion of extremities of right side; features not altered; tongue fell a little on right side. This new attack disappeared, however, more promptly than the preceding; and at the end of three days, the patient having entered the hospital, presented the following state:—She had slept well the previous night; some weight of head; tongue unsteady when she put it out; some numbness and weakness on the right side of the body; speaks distinctly; pulse full, strong, and slow; habitual constipation (lemonade, with cream of tartar); fifteen leeches to each foot; warm pediluvium, purgative lavement. In the morning she took some soup, and was seized with vomiting in the course of the day, when she threw up some bile; the vomiting brought on a new attack, followed by hemiplegia on the right side, and greater embarrassment of speech. She was bled to ten ounces; new attacks of a slight nature appeared in the night, upon which sinapisms were applied to the feet; after this the fæces passed involuntarily. On the 30th, hemiplegia more developed; articulation nearly impossible; pulse less full, less hard, and more accelerated; paralysis of the bladder (lemonade, with one ounce of soluble tartar, bleeding from the jugular vein, purgative lavement; introduction of the catheter.) Immediately after the bleeding (ten ounces) a new attack, followed by total loss of speech, and of motion in the right extremities, frothing at the mouth, dilatation of the pupil, countenance quite vacant. On the following morning these symptoms were all aggravated; trismus supervened, which prevented her from drinking, and constant drowsiness. On the 1st of May, pupils immovable, blindness, trismus, frothing at the mouth at each expiration, contractility abolished on the right side, almost none on the left, a little sensibility on both sides, rather more on the left: pulse full, hard, irregular for the number of pulsations (twenty leeches to the neck, blister to legs, purg. lavements). She died a little after the visit.

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* Andral, op. cit., p. 24.

Post-mortem.—Cranium.—The lateral ventricles contained nearly four ounces of limpid serum; no lesion in the thoracic or abdominal viscera.

Remarks.—The apoplectic attacks in this case seem to have been caused by simple sanguineous congestions in the brain. It would appear that here the hemiplegia was the result of a sanguineous congestion, greater in one hemisphere than in the other, whereby this hemisphere lost its influence over the muscular contractility, even when the congestion ceased to exist. The first time, the hemiplegia was preceded by a total loss of consciousness; the second time, it was gradual, and not announced by any symptom of apoplectic attack. The more alarming symptoms observed for the last two days were the result of serous effusion into the ventricles; of which the habitual sanguineous congestion had been probably a predisposing cause. We should not forget to notice here the influence of the vomiting on increasing the hemiplegia.

The following graphic account, derived from the Madras Journal, edited by my old fellow-apprentice, Samuel Rogers, is interesting in many points of view; and while it strikingly illustrates the value of cold effusion as a therapeutical agent in cerebral affections, it presents many facts highly instructive both physiologically and practically. After describing the circumstances under which the march was undertaken, and their exposure to the sun, the report goes on to say,* "About eight o'clock a most melancholy scene commenced; men were seen to drop down and instantly expire; others less severely attacked were saved by timely and copious bleeding. Every hour added to our melancholy situation; for notwithstanding our utmost exertions the day ended, I regret to say, with no less a loss than eighteen, and left us with sixty-three sick in the hospital. Our loss on this occasion, with one exception, was entirely confined to the recruits, and the chief part of the sickness that followed was also confined to them. The troops halted one day, and on the following day they lost three more.

"When warning of the attack was given to the patients, they usually complained of difficult breathing, with a sense of tightness and oppression about the chest, followed by giddiness, burning heat of the eyes, and a sense of general fullness about the head, in many amounting to excruciating pain, succeeded by loss of sense and motion, faltering of the tongue on attempting to speak, fullness of the eyes, dilated and fixed pupils, violent twitching of the muscles of the face, particularly those about the mouth, subsultus tendinum, and involuntary stools. Along with these symptoms, the patients also had a strong, full, and frequent pulse, tremendous throbbing of the carotid and temporal arteries, flushed, swollen, and sometimes livid countenance, and, throughout, a parched and burning skin.

"In so severe a form of disease, I could only look for success from immediate and profuse depletion; blood was accordingly abstracted from different assailable points, viz., the arm, the jugular vein, and the temporal artery. Cold was applied to the head, and at the same time the feet were immersed in hot water. Blisters were applied to the head, neck, and lower extremities; brisk purgatives were administered, and their operation assisted by purgative injections. When the disease terminated in fever, the rest of the treatment consisted chiefly in small doses of calomel and antimony. In several of the cases spontaneous vomiting took place, without producing any marked effect. No case of paralysis supervened.

* Madras Journal, vol. ii. p. 326.

"I have to regret that the situation of the corps at the time, and the severe duties I had to perform, rendered it impossible for me to examine any of the bodies after death.

"Considering the foregoing details of this affection, the full, quick pulse, the great heat of skin, the violence, suddenness, and urgency of the symptoms, venæ sectio seemed at once indicated, and it was carried ad deliquium, or to the relieving the patient. It was found that it sometimes required fifty, sixty, nay, even one hundred ounces of blood to produce this effect; and that the remedy sometimes was worse than the malady; for, though the first attack might be relieved, yet the subsequent symptoms required the same profuse evacuation for their relief; and from the previous loss of blood the patient was not in a state to bear such depletion. In fact, two individuals became convulsed, and, shortly after they were bled, died; and after death it was found, that although the heart was empty, the vessels of the head were loaded with blood. This clearly indicated that whatever it was that excited the heart's inordinate action, blood-letting would not subdue it; for as long as a drop of blood remained it was sent to the head. How lucky for us, and truly so for our patients, that we found in the *cold effusion* a most effectual remedy! Just as one man had expired, I might almost say under the lancet, another was brought into hospital. He was put into the bathing tub, and a constant stream of cold water poured on his head till he felt relieved. He was then put into bed, calomel ℈i. given to him, his head shaved, and cold wet cloths kept to it; and, in a few minutes after, as the heat returned, and the pulse rose, forty ounces of blood were taken from his arm. He was by these means perfectly relieved, and fell asleep; and as often as the pain and heat returned was the cold effusion had recourse to. This, with purgatives, leeches to the temples, and cold cloths to the head, cured him, as well as all the subsequent cases, when the men came into hospital in proper time, and the disease had not advanced too far.

"The history of the first person in whom the cold effusion was had recourse to as the principal remedial agent, would be but the history of all the subsequent cases. Some men required two or three bleedings, but they were not large, and we now found convalescence speedy; whereas, in the former cases that recovered, it was imperfect, uncertain, and protracted. The benefit of the cold effusion has brought to my recollection the advantages I formerly derived on the line of march with the left wing of H. M. 13th Light Infantry, from frequently pouring water on the men's heads when they felt oppressed; than which, nothing seemed to allay arterial action and nervous excitement so well; and so grateful was it to the men's feelings, that they used to get it two or three times in the course of the hour, at their own solicitation. It allayed the heat and thirst, and procured sleep."

Treatment of the Premonitory Symptoms.—Though it is not possible to say a great deal on this subject, inasmuch as each individual case will vary more or less, and must be treated on its own merits, or according to the circumstances which arise, and for the very reason that it is impossible to lay down very precise rules to guide the practitioner in all instances, it behoves him to bring all his powers of mind to judge and

discriminate between those symptoms which really threaten a coming storm, and those which arise from some temporary disturbing cause. There is no disease in which judicious medical advice may be of more service than in threatened apoplexy. It is the duty of every medical man to warn the friends of a patient rather than the patient himself, of those circumstances which might induce a fit of apoplexy in a form predisposed by disease to its occurrence. It is true that in many cases this is not possible; but when an attack has once occurred, then the medical man has it in his power to speak officially. In all cases the condition of the digestive organs must be attended to, especially the state of the hepatic circulation. All tendency to obesity should be corrected. A fat belly encroaches on the chest and interferes with the organs of respiration and circulation. But this must not be attempted rudely; habits that have been long established must not be suddenly changed. Violent exercise must be especially avoided. Moderate exercise, but plenty of it—moderate quantity of food, and that very simple—moderation in the use of stimulants, if they have been freely used habitually. The entire abandonment ought to be ultimately aimed at. If the tendency is very decided, and the threatening of an attack very strong, then all mental occupation should be abstained from, and the patient live a completely vegetative life. I sometimes say to my patients, "You must be contented to live the life of a cabbage." A mild aperient should be given every night to prevent any straining at stool, which is in itself most dangerous, and all patients should be warned against it. If there is the least appearance of bronchial disease, it should be treated decidedly and promptly by counter-irritation to the chest, and expectorants and mild sedatives. Congested lungs delay the blood on the right side of the heart, and this affects more or less the whole venous system, but especially the jugular veins and cranial sinuses. But the very act of coughing affects the cerebral circulation, and apoplectic effusion has occurred during its paroxysms. Dr. Watson mentions that a patient of his died from an apoplectic fit induced by straining in pulling on a wet boot. Loud talking, playing on wind instruments, singing, intemperance, venereal excess, the depending posture, and severe cold, are all referred to by this physician as occasionally exciting causes of apoplexy. If any discharge has been suppressed, either it must be re-established, or a fresh artificial one made.

Apoplexy.—Treatment.—In the treatment of apoplexy, the first thing to determine is not so much whether the effusion is serous or sanguineous, but whether it is of a sthenic or asthenic character, whether our patient will bear depletion, or whether he is depressed, and whether the disease itself is the result of exhaustion. With regard to our diagnosis of the seat and nature of the effusion, this is more important in relation to our prognosis of this disease than our treatment. I do not mean to undervalue careful diagnosis in these cases; on the contrary, I consider it of the greatest importance, and no pains can be too great which will assist us in coming to a right conclusion. In these cases the friends are of course extremely anxious, and our prognosis, whether favorable or otherwise, must depend on the conclusions we arrive at regarding the cause, the seat, and the nature of the effusion. If the *cause* of the

effusion be extreme plethora, and some accidental circumstance, such as posture, or straining at stool, without any disease of heart and vessels, then our prognosis might be favorable. If the *seat* of the effusion appears to be at the base of the brain, but not near the medulla oblongata, then it may possibly be remedial. These are merely illustrations of the fact, that though our treatment may be the same wheresoever the effusion may have occurred, and, in many instances, howsoever it may have been produced, our diagnosis ought yet to be made with the same care, and is of nearly the same value, as if the whole plan of our treatment depended upon it.

Our remedies in all cases are few and simple. First in the list stands blood-letting, the most valuable remedial agent in some cases, the most dangerous in others. Many a valuable life has been saved by the prompt and free use of the lancet: more have been hastened into eternity by its indiscriminate employment.

Dr. Abercrombie, whose opinion on these cases is so valuable, scarcely allows that there are any cases in which bleeding is not desirable. He says,* "In the extent of our evacuations, indeed, a due regard is certainly to be had to the age and constitution of the patient, and the strength of the pulse; but I think we have sufficient ground for saying, that there are no symptoms which characterize a distinct class of apoplectic affections, requiring any important distinction in the treatment; or, in other words, a class which in their nature do not admit of blood-letting. On this important point we may refer with some confidence to the facts which have been related. Weakness of the pulse and paleness of the countenance we have seen to be frequent symptoms of the worst forms of sanguineous apoplexy, and on the other hand we have seen cases terminate by serous effusion which were accompanied by strong pulse and flushing of the countenance. Finally, we have seen one remarkable case in which there existed every circumstance that could lead us to consider the disease as serous apoplexy, but which was fatal without any effusion; and another in which there was most extensive effusion, without any apoplectic symptom. It is likewise to be kept in mind that in apoplectic affections the strength of the pulse is a very uncertain guide, for nothing is more common than to find it, upon the first attack of apoplexy, weak, languid, and compressible, and becoming strong and full after the brain has become in some degree relieved by large blood-letting.

"It would be quite superfluous to detail common apoplectic cases treated successfully upon these principles. But it may be of use, in connection with this part of the subject, to select a few cases, which, occurring in old and infirm people, might have been considered either examples of serous apoplexy, or modifications of the disease not admitting of active treatment, yet under such treatment terminating favorably.

Case. 71.—"A woman, aged 70, of a spare habit, and thin, withered aspect, having walked out in her usual health, fell down in the street, speechless and paralytic on the right side. I saw her four or five hours after the attack. She was then much oppressed, but not entirely comatose. She was completely speechless and paralytic: her pulse about 96, and of tolerable strength. She was bled to 15 ounces; purgative medicine was ordered, with cold

* P. 288.

applications to her head. On the following day she was considerably improved, both in speech and in the motion of the right side; but having become rather worse towards night, she was again largely bled, and purgative medicine was continued. From this time she improved rapidly. At the end of the week she was able to walk with little assistance, and in a few days more was restored to perfect health."

At one time, this opinion of the imperative necessity for blood-letting in apoplexy was almost universal, but it has lately been much modified.

The deservedly high reputation of Abercrombie gave too much value to the use of the lancet in apoplexy, and it will therefore be well to turn to the opinions of other observing practitioners, and see if we may not find a safe middle path.

Dr. Bright's opinion is decidedly in favor of blood-letting as the general rule, and the omission of it should be the exception. He concurs with others in considering it our duty to bleed, and bleed largely, even when the pulse is slow and laboring. He is opposed to small bleedings, as they only relieve the heart of its load, and enable it to do more mischief, increasing the force of the circulation instead of diminishing it. If, after bleeding, the pulse increases in rapidity and volume, the lancet must be used again. But if, after the abstraction of forty or fifty ounces, no decided benefit is gained, then we must desist.

Dr. Watson, who considers blood-letting our sheet-anchor in certain forms of apoplexy, carefully distinguishing between those which require it and those in which it would be injurious, also advises, after one full and *sufficient* bleeding from the arm, to abstain from further use of the lancet.

Dr. Copland advises a full blood-letting, thirty or forty ounces at once, particularly when the attack has proceeded from exciting causes, and paralysis is not present.

The pulse is generally more or less intermittent and irregular on the first onset of apoplexy, so that this character by itself must not deter us from blood-letting, if at the same time it is not feeble, and thin, and quick, and the patient does not show other signs of general depression, such as pallid countenance and cold skin.

The same observations which I made regarding the treatment of inflammatory affections of the brain, apply to the treatment of apoplexy. The disease itself is most depressing, and in its treatment we must not consider simply the present moment—we must look also to the future.

We must not be satisfied in arresting the cerebral extravasation, but consider the possible condition of the brain afterwards. I am convinced, from observation, of what occurs in cases of injury of the brain as well as in true apoplexy, that large abstraction of blood gives rise to serous effusion. And every man engaged extensively in practice in London will bear witness to the frequent occurrence of delirium tremens, in either a slight or severe form, after the apoplectic symptoms have been subdued.

The next case exhibits those circumstances which indicate the necessity of immediate and decided blood-letting, and I think it illustrates the value of prompt treatment on the very onset of the apoplectic attack. I have no doubt that in this case all the vessels of the brain, especially the venous system, were excessively distended by blood rushing into them in the stooping posture, and that if she had not been bled freely at first, extravasation must have inevitably occurred.

I suppose that the sudden distention gave rise to some inflammatory action which the mercury and the leeches arrested, for it was not until the mouth became sore that her sufferings were put an end to. The endermic mode of exhibiting this mineral is the best in such cases where it is desirable to obtain its influence rapidly.

Case 72.—May 15th, 1846.—I was requested by Mr. Wildbore, of Shoreditch, to see a lady who was said to have fallen down in a fit of apoplexy.

The patient, Mrs. T., 40 years of age, stout, and rather full habit, temperate, and in comfortable circumstances; she has had seven children, the youngest 13 months old. She has been under Mr. Wildbore's care occasionally for the last five years, with symptoms of cerebral disease, but of so doubtful a character that a physician of high character who saw her about two years ago, pronounced them merely functional. The symptoms were varied; sometimes she expressed a feeling of numbness in her limbs; sometimes shooting pains in her head, and a feeling of swelling of the lips, lowness of spirits, and feeling of weakness.

The present attack came on when she was stooping to show her servant how to clean the fire-place. When she recovered her consciousness she stated that she felt a terrific pain in the head, and she said, "O Caroline, I am dying, take me up stairs." When she was laid down on the bed, she vomited, and almost immediately afterwards lost her consciousness; she did not remain wholly insensible for a long period, but seemed to be in a dreamy state for four or five hours, not able to speak, but evidently suffering pain, as evinced by putting her hand to her head.

Present state.—I found her lying on the bed, countenance slightly flushed. In answer to my question, whether she felt any pain, she said, "Yes, violent pain in the back part of the head." She had previously answered quite rationally some questions from one of her friends; her head was hot, but her feet cold; her pupils were rather contracted, but not extremely so; they acted freely to the light; no paralysis of either the face or the limbs. Pulse 56, and soft. She had been bled to about 16 oz.: this I was informed had not produced any material effect on the pulse; which certainly had not risen in frequency with it.

Ordered a blister to be made with a hot metal plate at the back of the neck, to be dressed with mercurial ointment. Turpentine enema immediately. Liq. hyd. bichlorid. ℥j. tinct. lyttæ, ʒifs. aq. cinnamon. ℥vfs. sumat. cochl. duo magna. 6^{tis}. horis.

16th, 4 P. M.—Rather better—quite conscious, but cannot move her head without suffering most violent pain: she feels, she says, as if her head were being split open; the light from the window distresses her. Her stomach is extremely irritable; vomits almost everything she eats; countenance flushed. She says that the cold lotion is very grateful to her, that without it her head would be intolerable; pulse 80. Ord.—Cal. gr. $\frac{1}{2}$. om. horâ. Hirudines xxx. capiti. Leave off the hyd. bichlorid.

17th, 10 A. M.—Has passed a quiet night, slightly better, stomach still very irritable, cannot keep anything down but a little milk, pain in the head not quite so severe. The leeches have not bled well or freely; the mouth slightly affected with mercury. Ordered—Rep. hirudines. Hyd. c. creta gr. ij. 6^{tis}. horis.

18th.—Decidedly better—bowels relieved, free from sickness, much less pain in her head; says she found decided relief from the leeches; mouth sore from mercury. Ordered—Leave off the mercury, and take Inf. armoracæ ℥j. Acid hydrocyanic dil. ♏iv.

19th.—She says she is not so well to-day; more pain in the head; which is hotter to the touch; she feels very sinking, she says, and that her eyeballs are painful; her countenance is flushed. The Inf armoracæ seems to have been too stimulating; ordered to be cupped to ℥vj. and to take a saline draught.

20th, 9 A. M.—She says she is better—that her head is easy when she is quite quiet, but that if she moves, it then swims; the leeches bled pretty well, and gave her great relief; countenance is still flushed, pulse 72, soft, tongue furred, mouth tender from the mercury, menses have appeared very profusely, a good deal of pain in the lower part of the belly, bowels purged. Ordered—Omit the last medicine, and take a simple effervescing mixture.

23d.—Going on well, head much more comfortable.

She recovered perfectly in about a week.

I have since seen this patient repeatedly, and she has had no return of the apoplectic attack. Though always a temperate person, I have made her abstain from *all* stimulating liquors, and take nothing stronger than water. She says that she has been decidedly more comfortable ever since she adopted this regime.

On being called to an alleged case of apoplexy it is well to accompany your messenger. In cases of emergency this is frequently one of the family, and much valuable information touching the history of the patient

and the advent of the attack may often be gained before seeing him. Inquiry should be made as to his age, and whether there is any hereditary predisposition to the disease; whether he is subject to fits, what are his habits of life, what his circumstances, whether he has had cause for anxiety lately, whether he has been harassed in business. The period of day at which the attack may have occurred will also of course suggest questions. As soon as the patient is in our hands, the neckcloth and collar should be loosened, the head raised, hot water ordered for the feet, and the pulse felt; as the first question which the medical man has to decide is to bleed or not to bleed, and on his correct decision hangs the momentous issue of the case.

Enough has been said to show that this cannot be decided by the pulse alone, nor by the countenance, the breathing, or indeed by the condition of any one organ or any one set of organs, but by evidence derived from them all conjointly, and the history obtained of the patient.

The broad features of those cases in which bleeding is desirable may thus be drawn, but the minuter details must be left to the discrimination of the practitioner at the time. The countenance may be either pale or flushed, if the pulse be strong, slow, full, or wiry. Whatever the state of the pulse is, if the face is flushed and the head hot, feet cold, patient under 60, and robust, and active; and the attack induced by excitement, whether of a psychical or physical nature, whether the result of mental disturbance or stimulating liquor.

Bleeding is contra-indicated if the countenance is pale, the head cool, the skin generally cold, the pulse soft, quick, and variable as to force and frequency, the patient old, his habits intemperate, or his diet suddenly changed from a stimulating to an abstemious one, or his having been exhausted by want of food and hurry in business.

If we decide to use the lancet, it is imperative for us to keep our finger on the pulse, and regulate the quantity of blood taken by its effects.

"The peculiarities of the pulse," says Dr. Burrowes,* "in apoplexy and other cerebral affections must, indeed, be noticed, but they are often very perplexing, especially when we are looking to the state of the circulation as an indication for treatment. But suppose a careful examination of the apoplectic or hemiplegic patient's heart discloses the existence of valvular disease to the extent of obstructing the circulation through its cavities, here the pulse will be a most deceptive guide as to the propriety or impropriety of abstraction of blood. If the mitral valve be principally implicated, and allow of regurgitation from the left ventricle, the small and irregular pulse so commonly observed with that lesion would probably dissuade from that free abstraction of blood which the cerebral symptoms might require. If in another case of apoplexy or hemiplegia, the aortic valves be found diseased to the extent of not only obstructing the onward current of blood, but also of allowing regurgitation into the ventricles, during its diastole, there will probably be associated with this lesion considerable hypertrophy of the left ventricle. There will be observed a full and vibrating or thrilling pulse, but a pulse of increased action without real power, and hence a deceptive

* Burrowes, op. cit., p. 143-0.

pulse; and one which, if it be regarded without reference to the structural changes of the heart, would invite to a more copious abstraction of blood than was called for by the general symptoms. In each of these last-mentioned cases greater relief to the symptoms will be obtained by a free local abstraction of blood from the vicinity of the heart (either by cupping from beneath the left mamma or between the left scapula and spine) than by a much larger depletion by venesection.

"Again, there are other instances of apoplexy and hemiplegia, where, from an examination of the heart by auscultation, we feel assured there is serious valvular disease; and, from the character of the cardiac murmurs, and other physical signs, we arrive at a well-grounded suspicion that there is osseous deposit about the valves of the left ventricle, in the coats of the ascending aorta, and, in all probability, in the tunics of the arteries within the cranium. In such a condition of the arterial system an accidental cerebral congestion may have been followed by extravasation of blood, and thus have arisen the most common symptoms of apoplexy. The knowledge obtained through auscultation in such cases would properly dissuade from large losses of blood, although the fullness and hardness of the radial pulse might at first have invited such depletion.

"There are other cases of apoplexy and hemiplegia where we discover dilatation of the cavities of the heart and extensive emphysema of the lungs; the latter lesion is, indeed, a more common cause of cerebral congestions and hemiplegia among the laboring classes than is commonly supposed. In such cases the appearance of extreme congestion and dyspnœa might tempt to practice large depletions, and thus the very symptoms of the heart which have induced the cerebral congestion and apoplectic symptoms would be aggravated. I should here suggest the employment of cupping-glasses to the nape of the neck, or between the scapulæ, with the internal administration of stimulating diuretics, diffusible stimulants, and the application of rubefacients to the sternum. Many mistakes arising from the causes I have now adverted to may certainly be obviated if a careful examination of the heart and lungs be made with the stethoscope in the first or congestive stage of apoplexy, or immediately after an attack of hemiplegia."

Though I think at the present time there is some danger of the profession falling into the opposite extreme of allowing their patients to die from a want of the lancet, it must be allowed that we are much indebted to Dr. Henry Holland and some others, who have pointed out in forcible language the mischief which accrues from indiscriminate blood-letting.

In the treatment of apoplexy, especially after the first serious symptoms are subdued, it is often much more important to do nothing than do anything. It often requires great moral courage on the part of the practitioner to combat popular prejudices, and it is often absolutely necessary to prescribe medicines which are inert, in order to prevent mischief being done by others. In such cases we can do no harm, and may do some good, by prescribing very mild diuretics.

Dr. Holland, in his most interesting and valuable work, entitled, "Medical Notes and Reflections," has a chapter, headed "Bleeding in Affections of the Brain," which he thus begins: "Is not depletion by

bleeding, a practice still too general and indiscriminate in affections of the brain, and especially in the different forms of paralysis? I believe that the soundest medical experience will warrant this opinion." He then points out a variety of cases where there is diminished nervous power, but which, from their resemblance to those in which there is an excess of arterial action, there is danger of their being confounded, as we have already considered under the head of anæmic affections.

The following observations bear so directly on the question before us, that I shall not hesitate to quote them.* "Even where the tendency to paralytic seizure is generally lessened by bleeding, as common practice would imply, it does not thence follow that abstraction of blood from the brain should be needful or desirable in immediate sequel to such attack. In many cases, it is undoubtedly otherwise. The paralysis, when depending on apoplexy, with extravasation of blood or serum, or on other cause of continued pressure, may come on by degrees, and admit of relief in its progress by emptying the vessels of the head. But often it occurs as an instant shock to a portion of the brain or spinal marrow, without any proof of extravasation or obvious cause of pressure; the shock itself being of momentary duration, though it leaves lasting effects on parts of the nervous system thereon depending. In these cases (and they are frequent) the physical causes of the change are little known to us. There are reasons for supposing that the nervous substance itself is often primarily affected. We have certainly no proof of mere pressure from fullness of vessels being concerned, to warrant large bleeding, especially after the stroke of palsy has actually occurred. The degree of coma attending and following these seizures is not alone sufficient cause for the practice, and will usually subside without it, where the original attack is not such as to endanger life.

"Looking, indeed, to the magnitude of the event which has occurred between, common reason would suggest a doubt whether the same treatment can be desirable immediately before and after a stroke of palsy. I do not mean to give this the weight of an argument. From the nature of the circumstances, it is extremely difficult to bring unequivocal proofs on the subject; but there is much cause to believe that the practice of bleeding in the latter case is often injuriously pursued. The risk, I believe, will generally be less from waiting a certain time, to observe the effect of what has occurred upon the circulation, the breathing, and the sensibility, than from hastily taking away blood at the moment of a great shock to the brain, and before we can rightly appreciate its consequences. This effect upon the greater functions of life, gives us, in fact, the best information we can have in guidance of further practice. But this we forfeit in great part by the disturbance any large depletion makes in the system, and particularly in the organs upon which these functions depend. The importance of this consideration may be readily understood. It is a point constantly before us in practice.

"Even where evidence is obtained of the fitness of bleeding soon after one paralytic attack, for the prevention of another, the question still remains as to the manner of this; whether, by copious depletion at once, or by smaller bleedings, repeated as observation may suggest.

* Op. cit., p. 45.

And this question the practitioner, while prepared for boldness in all fit and urgent cases, is bound always to keep before him; seeing, especially, that any great excess in the remedy may hurry on the very mischief it is sought to prevent. I believe that in most cases the latter method is to be preferred. It accords better with the state of our knowledge of these disorders; involves no irretrievable step; and in its progress affords the information most requisite to decide how far it should be carried into effect. Paralytic cases there presumably are of such a nature, that a few ounces of blood taken away at regular intervals will ward off a recurrence of the attack, which any large or sudden depletion would probably hurry on. The proof here can seldom be explicit, but the presumption is one I have often been led to entertain. These remarks, and the cautions they suggest, are familiar to many, and to such needless. But I feel assured, from what I have seen, that they ought to be carried further into general practice. The use of the lancet is easy, and gives a show of activity in the practitioner at moments when there appears peculiar need of this promptitude. Current opinions and prejudices are wholly on the side of bleeding; and the complexity and danger of the cases tend to obscure the results of the treatment pursued. The physician needs all his firmness to decline a practice thus called for, where the event is so doubtful, and where death may be charged upon his presumed feebleness or neglect."

"While making these remarks, however, I must be understood as recognizing, in the fullest sense, the value and need of this remedy, promptly and vigorously used, in various cerebral diseases, or in prevention of such, where well-marked symptoms lead to their anticipation. And I dwell upon this the more earnestly, lest, while merely inculcating a cautious discrimination as to the cases for its use, I may seem to be seeking reasons against the practice altogether. In active inflammation of the brain or its membranes—in many states of pressure from congestion in the head, topical or general, without inflammation—in cases where extravasation may be presumed to be going on—and even in other conditions of cerebral irritation less definite than these, we have no method of treatment equally effectual; and safety often depends solely on the speed and sufficiency of its employment. But almost in the same ratio with the necessity of the remedy in the above cases is the importance of refraining from depletion in other instances, often with difficulty to be distinguished from the former. And in the right direction of diagnosis and treatment here, we have the best proof that the mind of a practitioner is equal to the most difficult exigencies of his profession."

Mr. Copeman has published an interesting series of cases to illustrate the dangers of bleeding in apoplexy, which are worthy of perusal.

After the practitioner has relieved the immediate effects of the apoplectic seizure by blood-letting, carried as far as the circumstances of the case admit, he has still much to do. Mercury must be his sheet-anchor in every case, though the mode of administration may vary according to the constitutional powers of the patient, the amount of plethora, and the state of the bowels. The best plan is to raise the cuticle immediately, either by means of the liq. ammon. fort. or boiling

water, and dress the raw surface with the strong mercurial ointment. Calomel should be given internally in doses of two grains every hour, or five grains every four hours if the patient is plethoric, for twelve or twenty hours, watching the effect closely. If there is much debility the hydrargyrus c. creta in two or five grain doses is better. Emetics have been recommended, but they are dangerous.

The value of purgatives in the treatment of apoplexy, especially the croton oil, is acknowledged by every experienced practitioner. With respect to mercury, Dr. Bright gives the following practical hint: "We should be careful not to administer calomel before the powers of deglutition are sufficient to insure its being swallowed. I once saw most serious consequences result from this; for having put five grains of calomel on the tongue, and attempted to wash it down with a cathartic draught, the calomel, instead of passing into the stomach, remained, moved about by the tongue, and produced, in a few hours, a most alarming ptyalism, in which the tongue was forced out of the mouth, and it was necessary to scarify it deeply before it could be returned within the teeth."

In the treatment of apoplexy, after the first effect of the fit is subdued, the practitioner must always bear in mind that there is still remaining in or on the brain, extravasated blood, which has a tendency, like an extraneous body, to excite inflammation. After a day or two, when consciousness has been more or less restored, the patient may be observed raising his hand to his head, and showing, by his movements, that he is suffering in that direction. The head will be found unnaturally hot, and more so on the side opposite the paralyzed limbs, in a case of hemiplegia.

It is in this stage that leeches to the scalp and cold applications will be found especially useful, followed by blisters to the nape of the neck.

Diuretics may be employed with benefit, and the inf. digitalis with the bichlorid. of mercury is one of the best: the inf. armoracæ with spirit. æth. nit., or the inf. buchu, with tincture of squills, are also very useful and less active.

In the convalescent stage of apoplexy, after all the active symptoms have been subdued, but a certain amount of paralysis still remains, it is often a very difficult question as to what tonics may be employed with advantage. I believe that of the mineral tonics there are only two at all admissible: these are zinc and silver, and they may only be given in very small doses.

The power of nux vomica in stimulating the nervous system has induced some practitioners to employ it, but I am convinced it is a very dangerous remedy. I have seen it do much harm, and whenever there is any indication of either existing or latent inflammatory action, it must not be thought of. Dr. Bright says,* "In a case of local paralysis, I have applied this powerful remedy in doses of the $\frac{1}{8}$th, $\frac{1}{4}$th, and $\frac{1}{2}$ a grain to a blistered surface, with the effect of producing spasmodic action through the paralyzed muscle, and I have sometimes administered it internally with advantage. But cases of hemiplegia from rup-

* P. 338.

ture of vessels are not those in which this remedy holds out the greatest prospect of success, though with caution it may be employed in the advanced stages of convalescence, with safety, at least, and sometimes with benefit."

Dr. Burrows does not recommend strychnia in these cases. He says: "My opinion as to the effects of strychnia as a direct stimulus to the nerves in hemiplegia is even less favorable than that which I have expressed respecting electricity. In some cases strychnia does much harm by aggravating the wearing pains in the affected limbs to a much more acute suffering." He recommends friction as very beneficial.

After the acute symptoms have been removed, but paralysis remains, the bichlorid. of mercury will be found useful: thus, Liq. hyd. bichlorid. ʒi., Tinct. lyttæ, ♏x., Decoct. sarsaparill. ℥iv. ter. in die.

I have also seen decided benefit from the tincture of iodine, as a local application to the head. This was very evident in the following case, which is interesting in many other respects.

Case 73.—On the 9th of March, 1842, I was consulted by a Miss P., of Skinner Street, Holborn, for paralysis. When I first saw her she could scarcely articulate a word which was intelligible to me, though her sister, who accompanied her, was able to explain what she meant to say.

The right arm was quite paralyzed, much smaller than the left, the fingers contracted, the nails clenched in the hand, and very hard. The right leg not wholly useless, but she has very little power over it, and walks with the greatest difficulty. The motion of a carriage on the stones affects her head so much that she is obliged to walk as well as she can. I learn that she had lately been twice electrified at Guy's Hospital, but without any benefit, and that they subsequently refused to admit her as an in-patient, stating they considered her case incurable.

9th.—I prescribed for her hydr. c. creta gr. ij. Ext. Q. S. ut fiat Pil. om. nocte sumend., and the tinct. of iodine, to be painted on the back of the head, where she complains of most pain.

I learnt from her sister that she was first attacked on the 18th of May, 1840; that is, one year and nine months previous to my first seeing her.

Considers that she has always had a tendency to the rushing of blood to her head, feeling it in her face and head; had suffered more or less for years with headaches, but they had been much worse for about a month previous to this seizure, which she has since described to me as coming on with at first a loss of power in the arm and a difficulty of speech, but she was perfectly sensible, and immediately sent one of the family for the doctor; but in ten minutes from the occurrence of the first symptom she had lost all power of speech.

For the following details I am indebted to Mr. Fisher, of King Street, Snow Hill, who attended her at that time.

Miss P., aged 40, of spare habit, but previously healthy, sanguine nervous temperament, active, industrious habits. On the 18th of May, 1840, had ridden to Camberwell and back, arrived at home in the evening, and suddenly became hemiplegic, with complete loss of speech, intellect otherwise quite unaffected, pulse strong, full, and rather frequent. Venesectio ad deliquium, Hab. Ol. Tiglii gtt. iij. in pil. ij. quarum st. j. statim et rep. in hor. duobus.

19th.—Symptoms unaltered, bowels not acted on, a powerful purgative enema administered, and a purgative mixture given. Evening, cupped, and blister to nape of neck.

20th.—Bowels acted on freely—no alteration, cannot take medicine.

21st.—Strength sinking rapidly, dark thick typhoid fur on tongue, and other signs of extreme collapse. Small doses of Amm. Sesquicarb. every hour.

24th.—A little food at length taken, but no medicine; health improving, but the paralysis continues unmitigated. To take an occasional mild aperient, and small doses of Inf. Calumbæ, with tinct. Aurantii ʒj. every four hours.

June 7th.—Health has continued to improve under the above treatment, but only very slight improvement in the nervous symptoms; some motion in the leg; able to say yes and no; but although she evidently uses them as negative and affirmative, she uses them indiscriminately, very expressively nodding her assent, and saying at the same time, "no, no," and *vice versâ*, as often as using them correctly. She has also once been heard to pronounce the word Father. She has been requested to write, but cannot accomplish anything having

the least resemblance to a letter, although she could before write. She has never, from the first, had the least difficulty in understanding everything said to her, nor in making herself understood, so far as can be accomplished by signs, and by expression of countenance, which is not so much impaired, as the paralysis is not so complete in the face as in the limbs.

17th.—Able, with difficulty, to sit up; motion of lower limb somewhat improved; more command of speech, which is extremely imperfect. But the following facts have been with difficulty elicited. She had lost entirely the power of remembering all words, and of course the names of all letters; therefore, she could not read, although she perfectly recollected the purport of every word addressed to her *vivâ voce.* About this time I put her to the test by writing the word shell with another word, and showing her a shell, asked which word was the name of the object shown; after an effort she selected the wrong word, although it had no resemblance to the right one. In addition to the former treatment a stimulating liniment was now prescribed.

20th.—Seen to-day by Dr. Farre, who ordered her to take every four hours Tinct. Aurantii ʒfs. Spt. Amm. Arom. ♏iv. in Inf. Valerianæ ℥j. and to continue the liniment.

July 1st.—Removed to Camberwell, and was advised to continue the medicines with an occasional Aloetic aperient. The catamenia were during the whole time regular. The sphincters also performed their office efficiently.

20th.—Mouth becoming tender; first moved her arm slightly to day.

23d.—Can raise her arm to touch her forehead; feeling has partially returned; bowels confined. Pil. Rhei. co. gr. v. o. n. alvus constricta sit.

29.—Has gained more power in her arm and leg. Speech improving.

April 1st.—Not quite so well; appetite failing a little; to go on with the gray powder, in the dose of one grain, and take Inf. Aurant. co. ℥j. Tinct. Calumb. ʒj. Sodæ Carbon. gr. x. tres die.

6th.—Better again; more power of moving her leg; can now feel a little in her leg and toe the sensation of pins and needles; speech improved.

8th.—Complains of continual aching pains in the leg; speaks much better; can nearly say anything she wants, and the names of things which she could not before remember during her illnes she now remembers, and can say them; can raise the arm higher; finger nails softer; mouth very sore: to take only one grain of the gray powder at night, and use the chlorate of soda gargle.

13th.—Can raise the arm to the head; speech much the same; pains in the limbs less; sensation so much returned in the leg that she can now feel with it, whether it is hot or cold, which she has not been able to do before. Can read the newspaper to herself, and understand it, which she has not been able to do since her first attack.

25th.—Mouth and throat exceedingly sore; to discontinue all medicine, and use the gargle, and take Olii Ricini ℥j.

29th.—Better; occasional shooting pains in the limbs, and a sensation of scalding on that side generally, both in the limbs and face.

May 5th.—Improving; can now turn in bed, which she has not before been able to do; taking the Iodine and Gent. t. d.

22d.—When sitting up in bed reading, she felt a curious sensation down the affected side, and almost immediately afterwards lost all consciousness. She was found by her sister on the floor perfectly insensible, very pale and cold. A Mr. Cooke, the nearest medical man, was sent for, who sent her a draught, and said that nothing else could be done for her. She recovered her senses gradually.

23d.—I visited her this day, and found her much the same as usual, only that her speech was not quite so clear, and her power of walking less than before the attack. Her pulse was quick and exceedingly feeble; she said she had a little headache, but not much.

I ordered, Quin. gr. i. Pil. Aloes co. gr. ij. bis. in die.

24th.—The report of her sister is, that she is rather better, and does not complain of headache.

25th.—Very weak; no headache; bowels confined. Quin. gr. ij. Pil. Rhei. co. gr. ij. t. d.

July 22d.—She has remained out of town until a few days ago, and without any material change taking place. When I saw her to-day, I found her looking much the same as usual, the speech very imperfect. She complained of pain in her head, and I ordered her two leeches and a purge.

25th.—She did not apply the leeches when ordered, but the following day she suffered so much from her head, and felt as if she was going to have a fit, that she applied them, and found much relief.

Sept. 12.—Has not been taking any medicine for fourteen days, but she has continued the Iodine to the head; she is much better, both as regards her speech, and she can walk better, and feels her arm and foot much better, and is stronger in her general health.

26th.—Has continued to apply the tincture of Iodine to the head, and is improving: has more feeling in her side, and her speech is improving, and she is gaining strength.

Oct. 7th.—Considers that she is not so strong as she was.

Ordered her, Mist. Iodine ex Gent.

29th.—Had a fit this morning, which was considered by Mr. Fisher, who saw her at the time, to be a fainting fit; the sister says that she does not perceive any more paralysis in the arm or leg; a little more difficulty of speech; she got up with a headache, and felt sick; it occurred at eight o'clock; she has been suffering from headache.

Ordered—Cal. gr. ij. Pil. Rhei. co. gr. viij. h. n. haust. p. cras mane.

31st.—Better; but still feels a weight in the back of her head.

Ordered—Hirud. j. regioni cerebelli.

Nov. 4th.—Relieved by the leech from pain ever since. Her sister reports to me to-day that she is exceedingly weak, and that she is so excessively sleepy that she falls asleep as soon as she sits down in her chair, however great the noise. This symptom has only existed for the last two or three days. Bowels opened with the Conf. Sen.: appetite very good.

1843, January 2d.—Has been stopping at Hampstead, and is much better in every respect.

July 14th.—I lost sight of this patient since the last date, but I now learn that she is much better, can walk three or four miles, and her speech is better; she does not take any medicine, but continues the Tinct. Iod. to the head, and she finds if she leaves it off her speech becomes worse.

Convulsive Affections.—Convulsions, from *convellere*, "to tear or pluck up." The term is now confirmed pathologically to sudden, spasmodic, involuntary action of muscles. Convulsions are most frequently the effect of disease, either functional or organic, of the cerebro-spinal axis, sometimes the effect of injury. I do not purpose, in this place, to attempt an account of convulsive diseases generally, but only those which appear dependent on derangement of the circulation of blood in the brain, or lesion of its substance.

Let us first direct our attention to those convulsions which appear the result of direct violence done to the brain. In doing this, it will be found instructive to combine physiological inferences with those pathological deductions which are to direct the diagnosis and guide the treatment.

In considering the pathology of convulsions, I think it will be found that the same law holds good as in inflammatory affections. In inflammatory affections, we have already observed that mental excitement is an indication of inflammation or irritation of the hemispherical ganglion, and, I believe, it will be found that convulsions are indications of irritation or inflammation of the tubular neurine, either where it is in contact with the vesicular neurine, or in its course to the muscles, or of the vesicular neurine, from whence the power, which excites the muscles, emanates; thus confirming the truth of the law we have already investigated, that irritation of the cerebral substance, either by inflammation or mechanical means, first excites its normal action, though it may lead to its ultimate destruction.

I have quoted a case from Ollivier,* of "spontaneous hæmorrhage and rupture of the cephalic bulb of the spinal marrow and of the annular protuberance, accompanied with convulsive contractions of the limbs." This author says, "I have since had several opportunities of observing this apoplexy at the moment of the attack, and I have always remarked convulsive contractions in the upper extremities, with alternating movements of rotation inwards. The opening of the mouth underwent no

* P. 500.

change. The spasmodic convulsions observed at the commencement of the attacks of apoplexy in general, seem to me to depend on the irritation which the blood produces on the extremities of the torn medullary fibres, with which it remains in contact, and on which it must act as an irritant.

The following case, from Mayo's Outlines of Pathology,* seems to be highly instructive, though the narrator does not appear to have duly appreciated its important bearing on the physiology of convulsions.

Case 74.—W. Tucker, ætat. 42, brought into the Middlesex Hospital, and supposed to be intoxicated. He was drowsy, heavy, stupid, not insensible; answered some questions; the pulse small and slow. The left arm and leg powerless; face drawn to right side. When put to bed, he was seized with rigor, and complained of pain in the right side of occiput; in an hour afterwards the pulse rose, and the right side of the body became convulsed: v. s. ℥xviij.: the convulsions ceased for a time, then returned with extreme violence, threatening to suffocate him: v. s. ℥xl.: the respiration became more free, but the convulsions remained: he then became comatose. He continued insensible during the night, the breathing stertorous, right pupil dilated, left contracted, no pulse at the wrist: he died at 11 A. M. A large cavity filled with blood, partly clotted, occupied the centre of the right hemisphere of the brain: it did not communicate with the lateral ventricle, but opened between the sulci of the convolutions, which for a large extent were lined with it; between their summits streaks of clotted blood lay, resembling veins. There was slight sanguineous effusion on the surface of the anterior lobe of the left hemisphere. It is possible, but very unlikely, that this may have caused the convulsions of the right side of the body.

I confess I am surprised at Mr. Mayo's concluding observations, when cases like the following, related by Abercrombie, are to be met with so frequently.†

Case 75.—A man aged about 35, keeper of a tavern, and addicted to the constant use of ardent spirits, had been drinking to intoxication during the night betwixt the 12th and 13th of July 1816; and, about seven o'clock in the morning, was found lying in a state of violent convulsion. No account could be obtained of his previous state, except that during the evening he had drunk a very large quantity of whisky, and that when he was last seen, about three o'clock in the morning, he was walking about his house, but unable to speak. He was seen by Dr. Hunter at a quarter before eight. He was then lying on his left side, in a state of perfect insensibility, with laborious breathing; saliva was flowing from his mouth; his eyes were much diffused and greatly distorted, the cornea of both being completely concealed below the upper eyelid; pulse 120, full and soft. While Dr. Hunter stood by him he was again seized with convulsion; it began in the muscles of the jaw, which was drawn from side to side with great violence, producing a loud jarring sound from the grinding of the teeth. The spasms then extended to the body and extremities, which were first thrown into a state of violent extension and then convulsed for one or two minutes; they then subsided, and left him as before in a state of perfect insensibility. Similar attacks took place four times while Dr. Hunter was in the house, which was about half an hour; and he expired in another attack of the same kind about two minutes after. Blood-letting and every other remedy that the time admitted of were employed in the most judicious manner.

Inspection.—On removing the skull-cap an appearance was observed on the surface of the dura mater of coagulated blood in small detached portions. These appeared to have been discharged from small glandular-looking elevations on the outer surface of the dura mater, which were very vascular and highly gorged with blood. There were depressions on the inner surface of the bone which corresponded with these bodies. On raising the dura mater there came into view a coagulum of blood, covering and completely concealing the right hemisphere of the brain; it was about two lines in thickness over the middle lobe and became gradually thinner as it spread over the anterior and posterior lobes, and dipped down below the base of the brain. The coagulum being removed weighed about ℥v. On the surface of the left hemisphere the veins were turgid with blood, on the surface of the right they were entirely empty; but the source of the hæmorrhage could not be discovered. There was no fluid in the ventricles, and no other disease was discovered. The stomach being carefully examined, was found to contain nothing but air and healthy mucus.

* Part I. p. 208. † Abercrombie, c. x. p. 243.

Lallemand's observations on the opinions which used to prevail on the subject of convulsions on one side of the body, and paralysis on the opposite, in connection with wounds of the head, are so extremely apposite that I cannot resist quoting them.*

"You have just heard many different opinions founded on observations more or less incomplete concerning injuries of the head: thus some have admitted that inflammation of the brain produced convulsions on the opposite side, others that it produced paralysis, and others that it sometimes occasioned convulsions and sometimes paralysis; so that the convulsions (always of the opposite side) were produced by inflammation, and paralysis by suppuration; that is to say, by compression of the brain. Another series of observations brings forth other opinions.

"Salmuthius† found in a patient who had had paralysis on one side and convulsions on the other, an abscess in the hemisphere opposite to the paralyzed side.

"Daniel Hoffman (Dissert. de Sanatione rariss.) relates the case of a child who, having had a fracture of the skull on the left side, with considerable destruction of the brain, had paralysis on the right and convulsive motions on the left side. These facts, after all, are very common; there are few practitioners who have not observed them.

"Berenger‡ says that he has most frequently seen convulsions on the sound side and paralysis on the opposite.

"'It is to be observed,' says Dr. Hennequin, 'that when on one side of the body there are convulsions and on the other paralysis, the convulsions attack the side corresponding to the injured brain; but when convulsions alone are present, and on one side only, it is generally opposite to the injury.'

"You will find these facts described by various authors, very nearly in the same manner, among the most recent of which I will cite one to which the author's name attaches an imposing authority. This is what Boyer says:§

"'Paralysis is not the only disorder produced by compression of the brain and alteration of its substance. Convulsions are also sometimes caused by these affections. The greater number of observers who have remarked that paralysis always attacked the side opposite to that which was injured, have at the same time observed that when in this case convulsions occurred, they attacked the side opposite to that paralyzed, that is to say, the injured side, whilst the convulsive motions affected the side of the body opposed to the injury, when no paralysis existed.'

"Amongst the authors who have spoken of these facts, some have contented themselves by relating them, without endeavoring to explain them; others have thought that the same affection could at the same time produce convulsions on the injured side, and paralysis on the opposite. Boyer seems to be of this number, when he says 'paralysis is not the only disorder, &c.' And others, persuaded that the convulsions were produced by inflammation, and the paralysis by the mechanical

* Op. cit., p. 500.
† Obs. Medicor. Centuriæ tres, 4to, Bruns. 1648.
‡ Tract. de Fractura Cranii, 4to, Venet. 1535.
§ Traité des Mal. Chirurg., &c., tom. v. p. 109.

compression of the brain, have thought that in this case the hemisphere corresponding to the injury was at the same time inflamed, and compressed by blood, serum, or pus. But thus to explain these two orders of symptoms, required that the opinions of the ancients, generally received, should be rejected; and this is what is done. It is pretended that the symptoms of convulsions are quite different from those of paralysis; that the one manifested themselves on the injured and the other on the opposite side. So, inflammation and compression of the same hemisphere of the brain would show symptoms in the first case on the same side of the body, and in the other on the opposite. Although the mere relation of this suffices to show its absurdity, the notion has had a great many supporters.

"It appears that in Morgagni's time it was much accredited, for he speaks of it at great length, and combats it in many parts of his works.* After having called to mind the decussation of the fibres of the brain, admitted to explain the cause of paralysis on the opposite side, he finishes with this judicious reflection, which naturally presents itself to the mind: 'Igitur quam decussationem ad paralysim in latere opposito explicandam agnoscere debeamus quare ad convulsionem non agnoscemus.'

"Morgagni's argument, very plausible at that period, fell the moment that we were able to demonstrate, by the scalpel, the interlacing of the fibres of the brain, which was then but a hypothesis more or less probable. That even has not hindered this opinion from being propagated to us, and I have heard distinguished practitioners defend it warmly. Others, always after the same observations of injuries of the head, have admitted that convulsions could occur on the side of the inflamed hemisphere, or on the opposite side, whether this last was free or paralyzed—a circumstance much more difficult to be conceived.

"It has, indeed, been imagined that convulsions only occurred on one side, because the antagonist muscles were paralyzed, so that the healthy ones drew the others to their own side; for example, pulled the mouth towards one or the other ear, bent the body laterally, &c. But, without considering whether this action of the healthy muscles can be assimilated to the permanent contractions or tonic convulsions produced by inflammation of the brain, it is evident that paralysis of the muscles of the arm or leg of one side can have no influence over the limbs of the opposite side. Of all these explanations, the most reasonable, the nearest to truth, is that which was adopted by Mus, Donatus, Cesalpinus, P. Martian, Morgagni, &c.; they thought that in these injuries of the head the cause of the two orders of symptoms had equally its seat in the cerebral hemisphere which was opposite to the side of the body affected with paralysis or convulsions; but that this cause was of a different nature, that is to say, that it was a compression or a mechanical lesion of the one hemisphere which produced paralysis on the opposite side, and an inflammation of the other which produced convulsions on the other side. They were in that consequent with themselves, and they

* See Epist. Anat., xiii., Nos. 14, 17, 18, & 22. De Sed. et Caus. Morb. Epist., Nos. 46, 47, & 48.

explained in a very simple manner contradictory facts ; yet this opinion did not prevail generally, and for this reason :

" In many cases they indeed found on the injured side an effusion of blood, pus, or serum, on the surface of the arachnoid, or an abscess in the brain, alterations which explained the paralysis of the opposite side : but they sometimes only found the dura mater and arachnoid injected, with softening of the subjacent brain : nothing then proved that there had been compression of the brain. There existed the great difficulty: they did not find in the hemisphere of the side opposite to that convulsed, evident traces of inflammation of the brain, and the state of the arachnoid was thought of no importance, for two reasons : the first, as you have seen, is, that it is much more inflamed on the injured side than on the other ; so that by comparison they thought it healthy when red, injected and opaque, &c. ; the second is, that they did not think that inflammation of the arachnoid was more likely to produce convulsions than delirium.

" Some facts, certainly rather rare, threw into confusion the opinions of authors concerning convulsions and paralysis after injuries of the head. Paralysis was observed to take place on the side injured, and convulsions on the side opposite to it ; and even Avicenna, who probably had seen many similar cases, thought (De Fract. Cran.) that these were more common than the reverse. They were for a long time very much embarrassed how to explain this singular phenomenon, which overthrew the received ideas ; but when they opened the skulls of individuals who had died, they in a short time perceived that the lesion of the brain was opposite to that of the skull, and consequently opposite to the paralysis.*

" These two series of symptoms, then, explain themselves in the same manner as in the preceding case. I have seen no other means of exhibiting to you in the most simple and clear manner possible, this rapid sketch of all these opinions, and of the facts upon which they are founded, than by reducing them to their most simple expression, by depriving them of that vain parade of erudition, which is very easily abused, and amid which it is so difficult to see one's way.

" Yet with this precaution you will perhaps find that the labor which such an extent of reading requires is not compensated by the benefit reaped from it ; but I have thought that if others began to demolish before they build, or simply to pull down without leaving anything in the place of that which they destroy, I could, and I even ought, after endeavoring to build upon bases more extended and more solid than have up to this time been assumed, to try to make everything disappear that might oppose your progress.

" After all, you see that the cause of the errors which have reigned concerning symptoms of inflammation of the brain is, that they have been studied in surgical observations ; that great importance has always been

* Amongst others, see the case of Paillot, continued by M. Ant. Petit, in his collection of Clinic. Observ., p. 223. He received over the left coronal suture a sword cut ; the eighteenth day the left arm was paralyzed, the paralysis increasing by degrees, and he died the 26th day. Under the wound the dura mater and brain were healthy ; on the anterior lobe of the opposite hemisphere was a vast abscess which had penetrated many lines in its substance. See also Morgagni, Epist. LI., No. 42 ; and the Observ. of M. Dan de la Vauterie, Letter I. No. 19.

attached to the external wound, and little attention paid to the symptoms; and this in considering pathological observations, which are so much more complicated than cases of spontaneous inflammation.

"You also see that all these opinions were founded upon facts which have been reproduced in our own days, because nature does not change; although so very contradictory, it is easy to explain them, and even to reconcile them one with another."

Injuries of the head often give rise to convulsions. This fact is important, both in a surgical and physiological point of view. The appearance of convulsions after injury of the head is a most serious symptom. If it occurs within a few hours after the accident, it is generally indicative of laceration of the brain; if it does not supervene for some days, it is then dependent on subsequent inflammation.

The next case illustrates the fact that the convulsive fits sometimes occur after a blow on the head without fracture, and that the injury which gives rise to them is not always irremediable.

I have no doubt that the convulsive twitchings in this case were occasioned by some injury to the brain produced by the contre-coup, and the case is instructive from its showing how gradually serious symptoms will sometimes arise some days after the receipt of injury. The result of the local depletion and counter-irritation bear out this view of it, and the general tonic plan which was indicated by the previous habits of the man, and his state of constitution, is important to attend to, from the success which followed its adoption.

Case 76.—*Injury to the head*—William Pearson, æt. about 40, a pot-boy at a public-house, was admitted into George's Ward under my care, May 16th, 1842, with a small lacerated wound on the left side of the head; he was intoxicated at the time of admission. The accident was caused by his being knocked down or run over by a cart, I could not learn which.

The case was regarded by the dresser as one of intoxication, and I did not see him until the following morning.

17th.—He now complains much of pain in his head; but, with this exception, there were no symptoms indicative of cerebral mischief, and the headache I considered more characteristic of disordered stomach than brain. There was no drowsiness, and his manner was natural; he referred the pain to his forehead, and not to the seat of injury; his pupils acted naturally.

I ordered—Pulv. Jalapæ c. Cal. ʒj. stat. M. S. C. 6ta. hor. post.

In the evening, finding that, though his bowels had been relieved, the pain in the head continued, I ordered him Calomel, gr. v. 4ta. hora.

18th.—Symptoms much the same.

Ordered—Opium, gr. j. at night, and repeat the Cal. and Jalap. as a purge.

19th.—Has had convulsive movements of the left side of the face, of an epileptic character. Tongue drawn to the left side. Constantly spitting a large quantity of frothy saliva. Both pupils are alike, and slightly contracted, but act freely to the light. Pulse 116, weak. He is quite conscious, and answers all questions naturally, though he has not perfect power of speech. I again examined the head, and, for the first time, perceived that there was some tenderness on pressure on the right of the head, opposite the wound.

Ordered—Hirudines xx. to the right side of the head; to be followed by a blister.

Opii Tinctura, ♏xxx.; Spirit. Ammon. Arom. ʒſs.; Mist. Camphor. ℥j. hac nocte.

20th.—Says he found relief from the leeches, and his head is much better, though still very bad. Pulse soft.

22d.—No appearance of twitching, but tongue still drawn to the left side. Has vomited some greenish bile. Pulse soft.

Ordered—Hirudines xxx. to the right side. Port wine ℥vj. in arrowroot.

23d.—Says his head is much better, though not quite free from pain. Has only had one fit of convulsive twitching since the last report Pulse still weak.

Ordered—Quinine, gr. ij. b. d.

24th.—Much better; free from headache; no twitching since yesterday; appetite returning. Pulse weak, 80.

Quinine and a pint of porter daily, in addition to the wine.

This man perfectly recovered, and left the hospital quite well soon after the last report.

In fractures of the skull, the brain is sometimes lacerated, and it is interesting to contrast the effects of this form of lesion, when it is very limited, with the effects of concussion and compression.

The following case is interesting and instructive in many points of view. As bearing on convulsive affections of the brain, it is interesting inasmuch as the convulsive attacks did not appear until fourteen days after the receipt of the injury; the convulsions being most probably the result of the subsequent disorganization and irritation of the tubular substance of the hemispheres. The serious nature of the injury was masked by its small extent: this and other points will be adverted to when the case has been detailed, which is peculiarly instructive, surgically, as bearing on the use of the trephine (and to this subject our attention must also be directed); pathologically and physiologically, inasmuch as it shows that convulsions result, in some cases, from lesion of the cerebrum, and that they are not solely pathognomonic of spinal irritation and disease, as stated by Dr. Marshall Hall.

Case 77.—John Wingrove, æt. 33, a stone sawyer, of healthy appearance, was admitted into St. Thomas's Hospital, at a quarter before 8 A.M., on April 13th, 1843, with a compound fracture of the skull. The wound was about two inches and a half in length on the *right side of the head, near the posterior extremity of the vertex.* The scalp was completely divided, and the bone perfectly bare. The parietal bone was fractured in a fissured form; a portion of the outer table being depressed so that the fractured edge of the skull was distinct above it. Some blood flowed from the bone, but not much A portion of the leather lining of his cap had been driven into the wound, and was nipped so closely by edges of the bone that it was not easily removed. A small artery was bleeding on the divided edge of the scalp. I saw this man at a quarter before 9, about one hour and a quarter after the accident had happened. He was quite sensible; both pupils acted perfectly naturally to the light; he complained of pain in his head, but referred it principally to the forehead. There was no paralysis of any kind; pulse small, only 60 in the minute. The accident occurred at the New Royal Exchange, and was occasioned by a blow from the head of a mason's hammer which flew off from the handle, and falling about 30 feet struck him on the head and glanced off. He was completely stunned by the blow, and had no recollection of being put into the cab by which he was conveyed to the hospital, but he recovered his senses before he arrived there.

I ordered Cat. Lini. to the wound. Calomel gr. v. 3tiâ horâ.

½ past 12 P.M.—No change.

½ past 10 P.M.—Pulse 80, but not strong; says his head is much better, but he feels very tired, and cannot sleep; but this he is not surprised at, as he never can sleep well if he has not had his usual day's work.

He has taken five doses of the calomel, and the bowels have been copiously relieved; as he has no untoward symptoms, I have discontinued the calomel. Not more than two or three ounces of blood have been lost from the wound.

14th.—Going on well in every respect; no bad symptoms; almost free from pain in his head; pulse 64; suffers a little from cough. Linct. pro tussi.

15th.—Has had a good deal of pain in the forehead, which he attributes to the shaking of his head from the cough. His pulse 86, but not strong; loud respiration over the whole chest. No pain in the wound or neighborhood; bowels not open to-day.

Ordered—Calomel, gr. v. 4tâ horâ; Hirud. xxx. lateri capitis dextro. Head shaved. Pil. Ipecac. c. Conio. gr. v. 6tâ horâ. Emplast. Lytt. pectori.

16th.—Much better; his cough very much relieved; free from pain in his head; bowels not open to day; mouth tender.

Ordered—M. S. C. stat. To omit the Cal. till to-night. A poultice to the blistered surface.

17th, 9 A.M.—Has had a bad night; head very painful in the frontal region; pulse small, 80; looks uncomfortable; wound healthy, suppurating.

Ordered—Hirud. xxx. stat.

12 P.M.—better; very little cough.

To omit the Pil. Ipecac. c. Conio, and to rep. Hirud. h. n.

18th.—Much better as regards his head, but the cough still troublesome.

To repeat the Ipec. c. Conio, the blister on the chest not having risen well; to paint the throat and chest with tincture of iodine. Pulv. Rhei. c. Cal. gr. xv. h. n.

19th.—Much better in every respect.

20th.—Free from pain in his head, and the cough nearly gone.

21st and 22d.—I did not see him.

23d.—Going on well in every respect.

24th.—Apparently going on well, but as he still had pain in the head, I ordered twenty leeches, and Pil. Hydrar. gr. v. bis in die.

25th.—The same. Thus it appears, that for thirteen days after his admission, he had not a bad symptom.

26th.—I received a message from the dresser, saying that the man had passed a bad night and was in a good deal of pain in his head, for which he had applied twenty leeches. I saw him at 1 P.M. His head has been relieved by the leeches, but he complains of pain at the external angle of the right orbit, which pain appears to him to rise upwards from the jaw, and to shoot over the head. He states that he is free from pain in the neighborhood of the wound; his mouth is tender from the mercury. As the pain has so much of a neuralgic character, and possibly connected with this salivation, I ordered the mercury to be omitted, and the face to be fomented, after which an ointment containing aconite to be rubbed into the side of the face. At 5 P.M., when I saw him again, he had been relieved by the fomentation, but had not had the ointment, as there was not any aconite in the hospital. I ordered instead of it equal parts of the extract of belladonna and lard, to be made into an ointment and rubbed into the face.

Pulv. Jalap. co. ℈j. hâc nocte. M. S. C. cras mane.

27th, 12 A.M.—Pulse 80, soft, and rather weak; complains of his forehead and the side of the head, but no pain in the neighborhood of the wound. His countenance was anxious and distressed; the right pupil was dilated; the left natural. I thought at first that this might possibly arise from the application of the belladonna, but he complained of having lost the feeling in his left hand, and that he could not lay hold of things so readily with it. I need hardly say I regarded this circumstance with the greatest concern, as I feared the worst from it. He had another very serious symptom, viz. that on lying down he complained of his head throbbing violently.

I ordered the twenty leeches to be repeated, and five grains of blue pill twice a day; the head to be raised in bed. Immediately I quitted the ward I called the attention of the pupils who were with me to the serious character of his symptoms, and gave an unfavorable prognosis.

At 8 P.M. I received a message from the dresser, informing me that he had had a fit, and when I arrived I found him just recovering from a third fit. The fits were not preceded by any scream, but in every other respect they were all of a true epileptic character. As soon as he began to recover his senses he went off again, and just previous to this he became very violent, and was with difficulty retained in bed. I inquired of his wife whether he had ever been subject to epilepsy: she said no, but that she had heard from his mother that when a child he had been subject to fits. Coupling the invasion of these fits with the incipient paralysis observed in the morning, I considered it not impossible that there was some irritation from the internal surface of the fractured bone. I therefore determined to trephine. This was accomplished by making first a crucial incision of the integuments, and then, by the application of the trephine on the lower edge of the fissure in the parietal bone. After the removal of the portion cut by the trephine, I removed with the dressing forceps a small portion of bone with a sharp edge, about the size of a thumb-nail, from under the superior edge of the fissure in the internal surface, which evidently pressed on the dura mater. About eight ounces of blood were lost at the operation, but very little afterwards. I performed it just after the commencement of the fourth fit, as I found he was too excited after he recovered from one to permit any operation willingly. He had one fit shortly after it was completed, but no more during the night. The dresser, Mr. Fixot, sat up with him, and he tells me that the patient complained of a good deal of pain in his head, referring it principally to the forehead and eyebrow, but sometimes to the back part, near the wound; he dozed at intervals, and then awoke with pain; pulse very variable, sometimes thready, and sometimes a little fuller; cough occasionally occurred, always causing violent pain in the head.

28th, 9 A.M.—He has now paralysis of the whole of the left side of the head, body, and left extremity.

He knows me: complains of pain in his head, and wishes to sit up in bed: we raised him,

and then he complained of being faint. I gave him a very little weak brandy and water, and ordered some sal volatile occasionally. His pulse is weak: 100.

28th, 10 P.M.—Has had nine fits at intervals during the day, the last about half an hour before I came down; he is quite sensible between the attacks; the sister thinks that he has lost some power in the right arm. As he was now dozing I would not disturb him; pulse 80, small, but not very feeble; skin hot. In one of the fits the convulsions were very slight, and confined to the left side of the body, and he seemed scarcely to lose his consciousness. I learned from the sister that she had observed twitchings of the muscles on the left side during the afternoon of yesterday.

On Saturday he continued sensible, and did not appear to lose his consciousness even during the fits, for as soon as the convulsions ceased he would take up his handkerchief and wipe his mouth. He had fits every half hour, which began at 9 in the morning and continued till 4 in the afternoon, when twelve leeches were applied to his head, and he had no more till 11 o'clock at night, when he had a very slight one; but at 12 he had a very severe one, which continued one hour: he was perfectly conscious, and breathing natural; scarcely ever complained of his head, and then referred the pain to the right brow.

Sunday, 30th.—He had no decided fits, only twitching of the muscles; remained sensible till about 4 o'clock in the afternoon, when a great change took place; he turned very pale, and had more twitching of the muscles, and at twenty minutes after four had a fit, which lasted an hour and a half. After this he totally lost the use of his inferior extremities; all consciousness left him; he did not have another fit, but merely twitching of the muscles, and died at twenty minutes after 3, on the 1st of May, moaning a great deal and making a great noise, but for one hour before he died he never spoke.

Post-mortem, May 1st, 1 P.M.—*Head.*—After the cranium was sawn through, about half an ounce of yellow pus escaped, while endeavoring to detach it from the dura mater. When this was done we found the internal table of the skull fractured more extensively than the outer table, split inward from the upper edge of the fracture. A portion of this table which was thus split I had removed with the dressing forceps after using the trephine. The portions which remained could not have been removed without some force, as they were only partially separated from the surrounding bone.

At the time of the operation I did not detect this further depression, from a fear of separating the dura mater more than was absolutely necessary. But the appearance of this bone certainly teaches us that we are warranted in such cases (even in the absence of depression of the outer table, and the removal of the portions which are found at the edge of the opening made by the trephine), in searching carefully for any further portions that may have been separated.

Opposite this fracture there was a small opening in the dura mater of the size and shape of the extremity of the nail of the little finger, through which some softened brownish-colored brain was exuding. On turning back the dura mater, we found on the same side the whole surface of the arachnoidea investiens covered with healthy yellow pus. The arachnoidea reflexa lining the dura mater was coated with a thick layer of pus, so tenacious that it almost amounted to a false membrane.

The brain, corresponding to the seat of fracture, was much discolored. The centre of discoloration was of a dark, dirty-brownish hue, of a semi-liquid consistency, gradually becoming firmer, and shaded off to a dingy pinkish color towards the circumference, which was spotted with deep bloody points: a horizontal section of the brain about half an inch from the surface showed this very distinctly. The disorganization extended downwards into the lateral ventricle at the commencement of the descending and posterior cornua, involving a portion of the transverse commissure, but not either the thalamus or corpus striatum. The surface of the brain, where the arachnoidea had been covered with pus, was slightly softened in many places, but most so over the inferior edge of the anterior lobes of the right hemisphere.

The hemispherical ganglion was scarcely, if at all, altered in its condition: its color was healthy, neither paler nor deeper than usual; the edge, in some situations, was converted into a grayish-greenish tint, which Dr. Hodgkin attributed to a *post-mortem* action of sulphuretted hydrogen.

The pia mater and arachnoid on the left hemisphere were both perfectly healthy, and also on the surface of both hemispheres, where they are in contact with the falx major.

If the nature of the fracture in this case, and the injury inflicted on the brain and its membranes, as demonstrated by this *post-mortem* examination, could have been ascertained at the time of his admission, no one could have hesitated to use the trephine. Some fifty or sixty years ago the trephine would have been immediately applied with the view of

elevating the depressed portion. This operation, however, in the present day, is not as a general rule considered justifiable in the absence of symptoms of compression, or direct irritation of the brain. It is, then, a question for consideration why this condition was not detected, and how far it would be desirable to adopt a different course when a similar case comes before us.

As a *post-mortem* examination does not demonstrate the amount of lesion of the brain at the time of his admission, for much that we now observe is the result of subsequent inflammation and gangrene, let us endeavor, reasoning from other cases and the physiology of the subject, to establish this point.

In the examination of a case of this kind, during life, it is extremely important to enter minutely into all those signs which indicate any injury to the brain. First, the mental condition—this was perfectly normal; he was quite sensible, and his manner natural. Next, the state of the pupils—the iris is placed before that expanded surface of the optic nerve, the retina, as an intelligent curtain to guard it from injury. The vital contrivances by which it acts, and by which its action is directed, are so beautifully perfect, that the extent of the opening of the curtain is indicative of the state of the nervous apparatus it is destined to protect, by preventing such an amount of light impinging upon it as would be liable to injure it. In disease of the globe of the eye, the dilated pupil indicates more or less pressure on the retina by some cause in the globe itself, such as a permanently turgid choroid, &c. But if with a healthy eye, and in connection with a blow on the head, we find a dilated pupil, then we have the sign of some pressure or injury to the nerve in its course within the skull, or the ganglia in which it terminates.

The dilated pupil, then, indicates very serious injury to the optic nerve, or the nervous centres with which it is connected, though it may happen, as in the case of very severe concussion, that the injury is remediable. The contracted pupil, on the contrary, indicates an irritability of the nervous instruments, an undue excitement of their natural function, not an obliteration of it. You will sometimes see, in the case of injury of the brain, dilatation of one pupil and contraction of the other; where this is the case you will find the most severe injury of the brain on the side opposite the dilated pupil, as occurred in this case from subsequent inflammation and softening.

The next point to which my attention was directed in reference to the prognosis of the case, was the state of the wound, and the blood which flowed into it. Now the blood which flowed into the depression might be from a wounded artery of the dura mater, or simply from the bone. If from the dura mater, the injury was of course very serious: this I hoped, and believed, from its extent at the time, was not the case. It soon ceased, which gave me reason to hope that the inner table was not fractured. That the outer table may be fractured without the inner, has long been known. We have a very good preparation in the Museum at St. Thomas's, where there is considerable depression of the outer without any whatever of the inner table. But the *post-mortem* examination proved that at the time of his admission, the internal table of the skull was more extensively fractured than the outer, and that the fractured

portions were partially depressed, notwithstanding the entire absence of all symptoms of compression. These symptoms, as almost universally agreed to by surgeons, consist of an entire loss of consciousness; the mental faculties are smothered, and they cannot be roused. Many of the functions of vegetative life are also interfered with—the breathing is laborious and stertorous, not unfrequently the sphincters are relaxed, and the excretions are evacuated involuntarily. There are sometimes other symptoms, but these are the most common.

It may be said, if such are the symptoms of compression, why were they entirely absent in this case, where the inner table was depressed and driven in upon the brain? I am inclined to believe that the acknowledged symptoms of compression depend upon the extent of the hemispherical ganglion which is pressed upon suddenly, and that if only a very small portion of this ganglion is pressed upon, then its functions are not naturally impaired, in this case, and many others that might be quoted: nevertheless, you must not consider it more than an hypothesis of my own, and not as an established principle, but I conceive this is the only truly physiological explanation of this apparent anomaly.

The splintered portion of the skull lacerated the dura mater to a very small extent, and to about the same extent, but no more, was the hemispherical ganglion originally injured. The medullary or fibrous substance beneath was so shaken that blood was effused in small points, as may sometimes be observed in cases of simple concussion without fracture. On referring to treatises on injuries of the head, I have been surprised to find so many cases recorded in which very serious injuries to the brain have been unattended by serious symptoms of disturbed intellect; but, as far as I can judge from the loose mode in which *post-mortem* appearances are almost invariably detailed, they are all cases in which the injury is confined to the base of the brain, or the hemispherical ganglion has been but slightly injured in the first instance. It is a pity that surgeons who have written on this subject should have neglected to state the exact extent of the *surface* injured, for this fact is equally important in its physiological as it is in its pathological bearing; the ignorance of it having induced some well-meaning but foolish people to quote such uses in proof of their theory that the brain is not the organ of the mind—not distinguishing between the ganglion which is connected with the mind, and those which are not. The following case, quoted by Mr. Guthrie from Dupuytren, illustrates my view of this subject.

A young man had received a wound in the head from a knife, which healed in the usual way, leaving only a little pain which occurred occasionally round the cicatrix. Some years after, he was brought to the Hôtel Dieu in a state of stupefaction, with which he had been suddenly seized. An incision having been made through the cicatrix, the point of a knife was seen sticking in the bone, the removal of which gave no relief. The trephine was then applied without any result. The paralysis continuing on the opposite side to that on which the wound had been received, it was thought right to open the dura mater, and then to plunge the knife into the brain, when a large quantity of pus escaped. The paralysis ceased that night; he recovered his speech, became sensible, and entirely, though gradually, recovered.

In this case we may conclude, from the account, that the ganglion was only injured to the extent of the breadth and thickness of the knife, and no disturbance of the mind followed until an abscess formed, which, pressing on the ganglion from within, indicated its presence by the stupefaction and paralysis that followed.

The evacuation of the matter relieved the pressure, the senses returned, and the paralysis ceased.

Whether this explanation of the fact that we meet with cases of depression of the table of the skull without the ordinary signs of compression of the brain, be true in its physiology or not, the fact itself is a most important one to be remembered for its practical bearings.

On referring back to its progress, it will be seen that on the 8th, 9th, and 10th days after the accident, he was almost free from untoward symptoms: so well indeed had the case gone on, that my friend Mr. Travers, who had watched it with some interest, congratulated me on the favorable result of the anticipatory treatment which I had adopted. It may be fairly considered that these antiphlogistic measures, which were practised so early, stayed for the time the invasion of inflammatory action, though they did not entirely arrest it. His system was brought under the influence of mercury within 24 hours of the occurrence of the injury, and though he was not bled from the arm, for he never had a pulse exhibiting sufficient vascular action to justify it, 148 leeches were applied to the head.

The cough was much subdued by the ipecacuanha and conium pill, a blister, and the tincture of iodine to the chest.

But still the mischief went on, and thus I believe the fibrous medulla beneath the hemispherical ganglion became softened, as indicated on the eleventh day, by slight loss of sensation in the left hand. If the medulla had been materially altered in its texture, at the time of his admission, by the blow, there must have been paralysis at that time, and the fact of its not appearing till the eleventh day shows how slowly the softening and disorganization must have proceeded. The softening increased, and then an epileptic fit takes place, quickly succeeded by another, and another, and another, until, by means of openings made with the trephine, a splinter of bone was removed.

The principal cause of irritation is removed, and one more fit occurs immediately, and then they cease for about twelve hours, when they again recur, and though occasionally stopped for a short period by local blood-letting, they return at intervals, until the patient becomes quite insensible, remaining so for twelve hours previous to his death. This loss of consciousness I attribute to the pus we found effused on the surface of the brain, for until the pus was effused there was nothing to interfere with the hemispherical ganglion, and therefore nothing to affect the intellect; and neither the quantity nor quality of the pus was such as might not have been effused in the course of twelve or fifteen hours at the longest. I think the inflammatory action which caused it was occasioned *by* the epileptic fits, and not the cause of them. The cause of the fits I believe is to be found in the softening and gangrene of the fibrous or conducting substance of the brain.

Taking this view of the progress of the case, I cannot avoid the con-

clusion that if this patient had been trephined when he was first admitted, he would have had a better chance of recovery than by postponing it; and though it is impossible to say whether the brain was or was not so much injured at first as to have been irremediable, I candidly confess that I do not believe it was; for if such had been the case there must have been some symptoms of such a lesion, though it is astonishing from what serious lesion, both primary and secondary, the brain will recover. I believe that almost all the disorganization which the *post-mortem* examination exhibited in the right hemisphere of the brain was the result of inflammatory action, excited by the irritation of the fractured skull, and partly kept up and aggravated by the concussions occasioned by the cough. The number of cases on record in which patients have recovered whose brains have been seriously wounded, when the cause of irritation has been removed, should encourage us to make the attempt as early as possible to remove, if we can discover on what it depends. The difficulty in the present case was to ascertain the fact of depression of the internal table.

There is no point in surgical practice regarding which there is and has been so much difference of opinion as the use of the trephine. Mr. Abernethy's Treatise on Injuries of the Head was called forth in consequence of the difference of opinion regarding the line of practice that ought to be followed in particular cases. He relates seven cases of fracture, with depression, which occurred within one twelvemonth at St. Bartholomew's, that recovered without any operation, "showing that a slight degree of pressure does not derange the functions of the brain, for a limited period at any rate, after its application." After relating other cases, he goes on to say—"Such cases ought to deter surgeons from elevating the bone in every instance of slight depression, since by the operation they must inflict a further injury upon their patients, the consequence of which it is impossible to estimate. From all, therefore, that I have learned from books, as well as from the observations I have made in practice and from reasoning upon the subject, I am disposed to join in opinion with those surgeons who are against trephining in slight depressions of the skull, or small extravasations of the dura mater."

Benjamin Bell, whose System of Surgery was published in 1801, says, "Hitherto it has been a general rule to consider the application of the trepan as necessary in every fissure, whether any symptoms of a compressed brain have occurred or not; but due attention to the real nature of the fissure, and to the effects most likely to result from perforating the skull, will show, that although fissures may be frequently combined with such symptoms as require the trepan, yet they are not always, or necessarily so; and, unless when such symptoms actually exist, that this operation, instead of affording relief, must frequently do harm; for it is by no means calculated for, or in any respect adequate to, the prevention of these symptoms, and I have already endeavored to show that laying the brain bare is never to be considered as harmless, and, therefore, that it should never be advised but where it is probable that some advantage may be derived from it." In the present day these observations of Mr. Bell seem almost superfluous, but when we find such precepts as the following inculcated by John Hunter in his Surgical Lec-

tures, we need not be surprised that subsequent teachers of surgery should have felt the necessity of warning their pupils against the too free use of the trephine. "As we cannot tell for certain at the time," says Mr. Hunter, "whether the symptoms arise from concussion, compression, or from extravasation of blood, it may be more advisable to trepan, *as the operation can do no harm.*"

Mr. Lawrence relates an interesting case in a clinical lecture, published in the Medical Gazette, vol. xxi. p. 345, of a boy who recovered without operation, in whom the skull was fractured and depressed, the brain wounded, and portions of it extravasated through a laceration of the scalp. "In this case," Mr. Lawrence says, "as the bone was here evidently and considerably depressed, and as it was also probably driven in upon the brain, it would, I believe, have accorded with the principles of treatment generally admitted, to have performed an operation for the purpose of elevating and removing depressed and detached portions of the bone."

"The considerations which determined me to do this were, the favorable state of the patient generally, and in particular the absence of all symptoms indicating compression of the brain; the specimens in pathological collections, of very extensive injuries of the skull repaired by a natural process; the smallness of the external wound, which brought this case nearly into the state of simple fracture; the extensive incision of the integuments, and exposure of the bone, dura mater, and brain, which an operation would have involved; and the almost invariably fatal termination of such proceedings within my own experience in hospital practice."

Dr. Hennen, in his admirable work on Military Surgery, relates many cases to show that, in the absence of symptoms, the trephine should not be used, even when the bone is evidently depressed. He says, p. 288: "We have here sufficient proof that there is no absolute necessity for trepanning merely for depressed bones from gunshot, although few would be so hardy as not to remove all fragments that came easily and readily away."

All the cases which Dr. Hennen relates are well worthy of perusal, but I have only room to quote one short history in connection with the present case. "A soldier was shot in the head in the Canadian campaign. A fracture was the consequence, with a depression of not less than an inch and a half; but as no untoward symptom occurred, no operation was had recourse to. The man recovered, and went to the rear, where, at a distance of several weeks afterwards, he got an attack of phrenitis from excessive drinking, and died. As the existence of the ball in the brain was strongly suspected, an inquiry was made after death, and on dissection it was found lodged in the corpus callosum."

Mr. Guthrie, in his interesting and valuable work on Injuries of the Head, lately published, makes some excellent remarks on the best mode of proceeding in these obscure cases. "The inner table (says Mr. Guthrie) is sometimes broken in a peculiar manner, to which I believe attention has only been drawn by myself in my lectures, since trepanning has ceased to be the rule in all cases of fracture. In these cases the skull is cut rather than broken by a sharp cutting instrument, such as an

axe, sword," &c., just in fact as a piece of wood might be, while the inner table, like a piece of glass or brittle steel, is broken and splintered inwards. "These cases should be examined carefully. The length of the wound on the top, or side, or any part of the head which is curved and not flat, will readily show to what depth the sword or axe has penetrated. A blunt or flat ended probe should in such cases be carefully passed into the wound, and being gently pressed against one of the cut edges of the bone, its thickness may be measured, and the presence or absence of the inner table may thus be ascertained. If it should be separated from the diploe, the continued but careful insertion of the probe will detect it deeper in the wound ; a further careful investigation will show the extent in length of this separation, although not in width, and will, in all probability, satisfy the surgeon that those portions of bone which have thus been broken and driven in are sticking in or irritating the brain. In many such cases there has not been more than a momentary stunning felt by the patient ; he says he is free from symptoms, that he is not much hurt, and is satisfied he shall be well in a few days."

"An officer was struck on the head in Halifax, Nova Scotia, by a drunken woman with a tomahawk or small Indian hatchet, which made a perpendicular cut into his left parietal bone and knocked him down. As he soon recovered from the blow, and suffered nothing but the ordinary symptoms of a common wound of the head with fracture, it was considered to be a favorable case, and was treated simply, although with sufficient precaution. He sat up and shaved himself until the fourteenth day, when he observed that the corner of his mouth on the opposite side to that on which he had been wounded was fixed, and the other drawn aside, and that he had not the free use of the right arm, so as to enable him to shave. He was bled largely, but the symptoms increased until he lost the use of the right side, became comatose, and died. On examination the inner table was found broken, separated from the diploe, and driven into the brain, which was at that part soft, yellow, and in a state of suppuration." After relating several other instructive cases bearing on this point, he says: "The principle being laid down that it is right and proper to examine all such wounds with a blunt flat probe, in order to ascertain, if possible, whether the inner table is depressed or broken, the question necessarily arises, what is to be done when such depression and breaking down of the inner table are ascertained to have taken place? There can be no hesitation in answering that in all such cases the trephine should be applied, although no symptoms should exist, with the view of anticipating them."

"The old doctrine, it may be said, in regard to fractures generally, is revived in these cases, but on a principle with which our predecessors were not sufficiently acquainted. A patient very often survives a mere depression of the skull ; he may, and occasionally does, survive a greater depression of the inner than the outer table ; but I do not believe that he ever does survive and remain in tolerable health, after a depression with fracture of the inner table, when portions of it have been driven into the dura mater. If cases could be advanced of complete recovery after such injuries, I should not consider them as superseding the prac-

tice recommended, unless they were so numerous as to establish the fact that wounds of the dura mater and brain are not extremely dangerous. I have referred purposely to many cases in which a cure was effected after a lapse of time by the bone being removed; but they rather support than invalidate the principle I have inculcated. There are great objections, I admit, to the trephine being applied in ordinary cases of fracture, which are not attended by symptoms of further mischief; but the nature of the cases which I have particularly referred to having been ascertained, I maintain that the practice should be promp and decisive in every instance in which the surgeon is satisfied that there is not merely a slight depression or separation of the inner table, but that several points of it are driven into the dura mater."

I have thought it incumbent on me to dwell very fully on the justifiableness of the use of the trephine in such fractures of the skull where there is an absence of cerebral symptoms. Nevertheless, I cannot recommend the use of the trephine in any case, unless there is very decided evidence of a wounded dura mater from splintered portions of the inner table. "If there be any doubt," says the same authority, "on the mind of the surgeon whether there are, or are not, any portions depressed and irritating the brain or its membranes, he should wait; and in this it is that the real difference between modern surgery and that of the olden time exists, with respect to adults."

The nature of the fracture in this case rendered it almost impossible to ascertain the fact of fracture of the inner table by means of the probe, as recommended by Mr. Guthrie.

It will be perceived, from these few quotations, that there is still considerable difference of opinion as to any general rule for the use of the trephine in fracture of the skull. It must, indeed, be admitted that no general rule can be laid down, but that every surgeon must be guided by the peculiar circumstances of each particular case, bearing in mind that there are cases of injury of the brain in which the trephine may be required, though all the symptoms of *compression* are absent. Such cases, it is true, are rare, and their diagnosis difficult, but it is only by the remembrance of their occasional existence that we ever detect them.

And, on the other hand, scarcely any extent of wound of the skull, the brain, and its membranes, accompanied with unequivocal depression of bone, should dissuade from the operation, if the functions of vegetative life are not so seriously interfered with as to make a fatal result inevitable; for the records of surgery teem with cases showing from what serious injury of the brain some patients will recover.

The next practical point which the consideration of this case suggests, is, whether we are justified in opening the dura mater when it has been exposed by the trephine, in those cases in which there are symptoms of pus beneath its surface.

The dura mater, when exposed by the removal of a portion of the skull, will be seen to rise and fall with the pulsations of the brain, if it is not separated from the dura mater by anything else than the other investing membranes. It is true that in a tranquil state, and with a small opening, the motion is very slight. The absence of this motion is stated by Mr. Guthrie as diagnostic of fluid beneath. "I have seen," says

this author, "on the removal of a portion of bone, the dura mater rapidly rises up into the opening, so as to attain nearly the level of the surface of the skull, totally devoid, however, of that pulsatory motion which usually marks its healthy state; and an opening into it under these circumstances has allowed a quantity of purulent matter to escape, proving that the unnatural elevation of the dura mater was caused by the resiliency of the brain, when the opposing pressure of the cranium was removed. I consider this tense elevation, and the absence of pulsation, to be positive signs of there being a fluid beneath requiring an incision into the dura mater for its evacuation. It is a point scarcely, if at all, noticed in English surgery, although much insisted on in France. It was not in the slightest degree understood till the commencement of the war in the Peninsula, and was one of those points which particularly attracted my attention."

In Wingrove's case, no such phenomena were exhibited at the time of the operation, nor did I perceive it when I examined the wound at my daily visits, which would rather confirm the opinion that the pus was not effused until about twelve or fifteen hours before death.

If I had observed this sign of the presence of matter under the dura mater, I confess that I should have punctured it, though I cannot believe, from the *post-mortem* examination, that the operation would have altered the result, as nothing could have changed the gangrenous condition of the brain. There are many other points of interest connected with injuries of the skull, and the use of the trephine, not bearing upon the present subject, which I shall notice in another place.

I cannot conclude these remarks without again adverting to the importance of making a very careful diagnosis and prognosis in all injuries of the skull; and that while we value the trephine and elevator as most useful instruments for the relief of a compressed and irritated brain, we must never be tempted by the prospect of performing what, if successful, is certainly a brilliant operation, but blamefully mischievous if the condition of the parts should not absolutely require it, without having first a well-grounded conviction that its use can alone save the life of our patient; remembering that in all such injuries the great danger to be apprehended is inflammation of the brain and its membranes, and that nothing is so likely to produce it as their exposure to the air, and the forcible removal of their natural protectors.

The next case is one of great interest in every point of view. I have never seen convulsions following injury to the brain of such frequency and severity which have been survived. That the cerebral lesion must have been very serious, is proved by the paralysis of the arm and leg. In a therapeutical point of view, it is important to observe how obstinate the symptoms were until the system was influenced by the mercury. I have no doubt but that the blood-letting arrested the inflammatory action until the mercury performed its work, but it did not appear as if the blood-letting alone could control the disease.

Case 78.—Thomas Smith, a boy æt. 14, residing at Woolwich, was admitted into George's Ward, May 11th, 1846, under the care of Mr. Solly, with a severe injury of the head.

It was stated that he had fallen from a scaffolding twenty feet, or upwards, in height, pitching upon his head; when picked up, was quite insensible, and there was bleeding from the right ear.

The accident occurred at 7 A. M., and he was at once sent to the Hospital.

Mr. Solly saw him at half-past 9, when he was still insensible, and evidently suffering from a severe concussion of the brain. His head was directed to be shaved, a cold lotion to be applied, and warmth to the extremities; and five grains of calomel were given immediately.

At half-past 1 he was again seen by Mr. S., when he had recovered his senses, but was very drowsy, and complained of pain in his head; the pulse was somewhat slow and laboring, the pupils dilated, particularly the left, but contracted upon the admission of light. He was ordered to take two grains of calomel every two hours, and to have twenty leeches applied to the head.

At 9 P. M. was much the same as in the middle of the day. Was bled from the arm to ℥viij.

May 12th, half-past 8 A. M.—He complained still of pain in the head, continued drowsy; pulse 72; bowels not opened, although he had taken eight doses of mercury. Ordered Calomel gr. v. every hour until the bowels were relieved. Leeches to be repeated, but thirty in place of twenty.

1 P. M.—To continue treatment.

11 P. M.—Was sleeping; sensible when roused, but complained of pain, particularly on the left side of the head. Bowels still confined; had taken nine 5 gr. doses of Calomel. Ordered an enema to be administered immediately, and repeated, if necessary. The Calomel to be omitted until the morning.

13th.—Sleeps a good deal, and he is not easily roused, but quite sensible, when awakened. Said, "I have got the headache, sir," and then dozed off again; pulse 64; bowels opened twice by the enema, stool lumpy, and dark brown. Ordered Calomel gr. v.

1 P. M.—Rather more drowsy; becoming forgetful; leeches to be repeated, thirty in number.

7 P. M.—The sister observed that he had slight grating of the teeth, and almost immediately thrust his tongue from his mouth, and it remained out; at the same time, the right arm was drawn up, and there was rolling of the eyes. The sister thought he was conscious, but he could not speak. She then sent for Mr. S., which was at

8 P. M.—His countenance had become more anxious; he was not so readily roused, and answered less perfectly questions put to him, speaking in a drawling way; pulse 76, not so full. A vein was opened in the arm, but the blood, which was very dark, flowed so slowly, that the temporal artery was opened. He was raised from the pillow, and as soon as little more than an ounce had flowed, he had a convulsive fit; the struggle was slight, and accompanied with a slight moan. The artery was then completely divided, which stopped the bleeding, and he was again laid on the pillow; he almost immediately recovered his consciousness; his countenance was pale, and covered with cold sweat; pulse 56, irregular. In a few minutes he seemed better, and said, in answer to a question, that he was easier. Ordered Hydr. c. Cretâ gr. ij. 4tâ hor.

14th *mane primo.*—Said he was very bad; quite conscious; has had no more convulsions; complained of his head. Pulse 72, soft; mouth rather tender.

9 P. M.—Countenance more cheerful; head cooler; pulse 80. Said he was better. Continue treatment.

11 P. M.—Had another convulsive fit, which was very short; foaming from the mouth, which was drawn somewhat to the right side; no scream. A few minutes before this, he had started up in the bed, and would have fallen out, but for the attendant.

15th.—Several fits of short duration have occurred during the night.

Half past 8.—Countenance very heavy and dull; scarcely any answer given to questions; right side of face and arm partially paralyzed, but can feel somewhat when pinched; bowels not open. Continue the Hydr. c. Cretâ.

Half-past 7 P. M.—Has had several fits, but not of great length, nor severe; countenance much the same; answers slowly, but rationally. Bowels relieved; motions loose and green; pulse 80. Continue the Hydr. c. Cretâ. Empl. Lyttæ to chest. Acet. Lyttæ et Ungt. Hydrarg. ad eundem.

16th.—Not so conscious, nor so well in other respects; pulse 80. Continue treatment.

17th.—Very drowsy; has frequent fits, some of longer duration than before; countenance heavy and bad; pulse 140; cannot get him to take food; is not aware when it is offered him.

18th.—Much worse; countenance continues anxious; can scarcely answer any question; pulse 156, small. Says he wants his breakfast; always expressing a feeling of hunger. Convulsions occur very frequently.

19th.—Countenance more anxious. Says he is better, and that the pain in the head is less; has greater difficulty in speaking, and is certainly worse. Continue Mercury.

20th.—Appears much the same; says he feels better; pupils both act to light; the right arm is paralyzed, but not the leg; the convulsions continue.

21st.—Convulsions not so frequent in occurrence, but continue for a greater length of time, and are more violent; he is not so drowsy; his countenance has improved, and he says there is less pain in the head; pulse 130; bowels open. Continue treatment.

22d.—The convulsions continue very violent, but occur less frequently even than yesterday; his countenance has much improved; pupils act; pulse 120; bowels open. Says he is better, but complains of his head.

23d.—There is little alteration as regards the frequency and violence of the convulsions. He has the power of moving his arm, which was paralyzed on Wednesday; countenance continues good; pulse 120; bowels open; mouth beginning to get a little tender. Continue treatment.

24th.—Has had no fit since last night; appears much relieved; the pain in the head diminished; countenance good; bowels open; tongue cleaning; pulse 112; complains of his gums. Continue treatment. Apply cold lotion to head.

25th.—Mouth sore; continues free from fits; complains less of pain in the head; has quite recovered the power of his arm; pulse 108; bowels open; appetite good. Continue the pills night and morning, instead of every sixth hour. Discontinue the application of the ointment.

26th.—Has passed a good night; no recurrence of the fits; pain in the head slight, and confined to the frontal region; bowels open; pulse 108.

27th.—Says he is better; has but little pain in the head; tongue cleaning; pulse 112; bowels confined. Ordered Comp[d.] Colocynth pill, gr. x., to be repeated, if necessary. His bowels were relieved before the Colocynth was given, therefore no purgative required.

28th.—Is progressing favorably.

June 3d.—His gums are still tender, and he is generally much better. Ordered Hydr. c. Cretâ every other night, instead of night and morning.

7th.—Is much improved; has no pain in the head, or elsewhere; bowels regular; tongue clean; appetite good; pulse 90.

13th.—Appears and describes himself as feeling quite well; is rapidly gaining strength. To discontinue the pills altogether.

This lad recovered perfectly.

Epilepsy.—Επιληψις, from Επιλαμβάνω, "to invade, attack, oppress." Of all the various ills that flesh is heir to, this is the most distressing to witness. It is no wonder that, in ancient times, the poor afflicted mortals who suffered from its influence were supposed to be possessed of a devil. For there is no doubt that the Demoniacs of Scripture were epileptic patients.

As soon as medicine was cultivated as a science, epilepsy was treated as a disease, and recorded by medical writers.

Hippocrates described it under the title of *Morbus sacer*, and scouted the idea of demoniacal possession; and we learn from the able translator of the works of Paulus Ægineta, (Mr. Adams,) that Galen, Oribasius, Ætius, Aretæus, Pseudo-Dioscorides, Alexander Leo, and a host of others, including Rhases, have devoted their attention to the complaint. Dr. Copland, whose learned article on this subject ought to be perused by every member of the profession, says, that by none has it been noticed so fully and accurately as by Aretæus.

The outward signs of the disease, when fully developed, consist in the occurrence of convulsive fits, so striking, so frightful, and so peculiar, that, when once seen, they can never be mistaken, either by physician or layman, for any other disease. I say when fully developed, because, as a general rule, the fits do not attain their characteristic peculiarities all at once. The disease is usually progressive. In a practical point of view this is most important. For the time to combat the disease with most chance of victory, is, as in apoplexy, during the occurrence of the premonitory symptoms, when the disease is only in embryo.

The following is the usual order of phenomena which constitute an *epileptic fit*. The patient may be sitting at the dinner-table, or in a gig, or anywhere, in the apparent enjoyment of perfect health, and his face will become suddenly flushed, there will be a slight convulsive action of the lips, and then a scream, more unearthly and horrible than any sound uttered by living creature. The railway whistle makes some approach to it. The whole body now becomes convulsed, and the patient, if sitting, is generally thrown from his seat by the convulsive action of the flexor muscles, and he falls forwards. If he is standing, he generally falls in the same way. Sometimes, it is true, there is a short, slight warning, which enables him to lay himself on the ground, and save the violent concussion of the face.

By the convulsive paroxysm, the jaws are fixed, and in the suddenness of their closure, the tongue is usually severely bitten. The expression of suffering is agonizing. Bloody, frothy saliva issues from the mouth. The head is drawn down upon the chest, the body curved forwards, the thighs flexed upon the pelvis, the hands violently clenched. The convulsions are usually more on one side than the other, and the same side always affected. The countenance is livid and distorted. In the neck the carotid arteries may be seen distended, and pulsating violently. The seminal fluid is generally ejected during the paroxysms by the violent convulsive action of the ejaculator muscles. Gradually the muscles relax, the eyes open bloodshot, and are turned upwards with the ghastly expression of death. The breathing is slow, gasping and stertorous, and the poor sufferer presents all the appearance of one about to quit this earthly scene. In a few minutes more the countenance becomes natural, and the breathing gradually less stertorous, and now, if he is undisturbed, he will fall into a deep and tranquil sleep, from which he wakes in about half an hour, or an hour, wholly unconscious, until some minor circumstance acquaints him with the fact that he has passed through this fearful ordeal.

The consequences of the severer paroxysms vary very much. In some cases, the patient opens his eyes a few minutes after the attack, and looks about him as if nothing had happened, but generally there is complete coma. If the fits come very close together, and in any number, the coma will last some time—for days, and even a week.

Sometimes it is succeeded by complete mania. I was consulted, a few days ago, by a gentleman, who told me he was always raving mad for a few days after a series of fits. The effect of the fits depends a good deal, also, on whether the patient is kept quiet or not. If he is disturbed or annoyed by seeing strange faces around him, he is generally much worse. On one occasion I saw a gentleman who usually had only five or six fits at a time, and these spread over a period of a week, with intervals of six weeks or a fortnight; but on this occasion he had twenty-four in forty-eight hours, occurring regularly every two hours, almost to a minute. The unusual number appeared to have been produced by mental excitement, for after the first fit he wanted to get up, and leave the house, which was new to him, and the servants prevented him; this rendered him very violent, and as he was a strong, powerful man, a great deal of force was used to restrain him. After this long

series of attacks, he was insensible for four days, and did not entirely recover his intellect for more than a fortnight.

Such, then, are the general features of a true and complete epileptic paroxysm, or *fit*. The disease does not always exhibit itself in precisely this form; there are many modifications of it, particularly in its commencement. It is very necessary to be aware of these varieties, especially as their serious nature is sometimes overlooked, until a true epileptic fit occurs, which draws a veil from the disease, painfully exposing its hideous form to the horror-stricken friends and astonished medical adviser.

The milder attacks, or half-attacks, as many patients call them, also vary in their intensity. Sometimes there is a momentary unconsciousness: if the patient is walking, he will stop suddenly, and gaze for a few seconds quite vacantly, or he will turn round and look on the ground, as if he were looking for something that he had lost. See Case 79.

Patients are generally aware of having had these attacks, and they will tell you how many they have had in the day.

These half-attacks are sometimes more severe—the *petit mal*, as it is called by the French. There may be a slight convulsive movement of the face or lips, and the state of unconsciousness last longer.

In one case, they used always to prove the *finale* of the series of fits, and until the half-attack came, the patient and his friends felt insecure as to the occurrence of more fits.

It is curious that sometimes these half-attacks derange the intellect more than the complete attack. It was decidedly so in the last case referred to.

Foville observed that the *petit mal* was attended with more disturbance of the intellect than the complete attacks.

Warnings.—These vary considerably, both as regards the disease generally, and individuals in particular. Some patients that I know have a warning at night, and not in the day. Others say that they used to have a warning when the disease first came on, but that they do not now; some have headaches, and feel fullness of the head; others experience a most disagreeable odor for a day or two; others, again, are particularly well, cheerful, and clear-headed. One boy is always excessively mischievous and high-spirited just previous to an attack, and his thumbs are drawn into the palm of his hand, as in children affected with crowing convulsions. This turning in of the thumbs is a very common sign of the approach of the attack. Some patients are always found lying on their face a night or two previous to an attack. In many cases there is sufficient warning to enable the patient to lie down, if walking in the road, on a bank, out of danger, and place a handkerchief in the mouth, to prevent the tongue being bitten. Sometimes patients will attempt to speak, to call the attention of a friend, but they can seldom articulate distinctly. One patient has always convulsive catchings or twitchings in the right leg for a night or two previous to the fits. I have others who always have a violent pain in the stomach previous to an attack. Another, who says she always knows when an attack is coming on by everything looking different; she cannot define the appearance, though she says she has often attempted. One gentleman I knew had sufficient

warning, which was a singing in the ears, to enable him to get off his horse. On one occasion, he did so in Shoreditch, and reached a shop before he fell. I have a young lady under my care, in whom the fit has more than once been averted by pinching the nose, and sometimes she has sufficient warning to cry out, "My nose, my nose."

The most curious warning is the *aura epileptica*; this term is applied to designate a sensation which originates in one of the extremities, and passes upwards, in the course of a nerve, to the head. It precedes the fit, and patients who have experienced it say, that they feel it distinctly until it reaches the head, and then they lose all consciousness. They sometimes describe it as a cold, sometimes as a warm, feeling, but always as a creeping sensation like "pins and needles." It is not common; out of between forty and fifty cases of epilepsy that I have seen, I have only met with it once.

Sir Astley Cooper used to relate, in his lectures, a curious instance in which he cured a case of epilepsy by the removal of a portion of the radial nerve. He said, "A man was sent to me, by a surgeon of Watford, having this disease; he would occasionally be seized by a severe pain in the thumb, which gradually extended up the arm, in the course of the radial and brachial nerves, through the axilla to the neck; his head would then become twisted, and in a moment he would drop on the floor in a fit; shortly afterwards he would get up, and appear as well as ever. I cut down upon the radial nerve by the side of the flexor carpi radialis longus, exposed about an inch, and removed five-eighths of it. After this the pain entirely left him, and he returned to Watford, where he remained completely cured."

Sauvages is of opinion, that the sensation has its origin in the brain, though it is referred to the limb, just as a man who has lost his limb still thinks he feels his toes.

There is no period of life at which these fits have not been known to occur; they are not frequent in infancy, or in extreme old age; but I once knew an old gentleman who was attacked at the age of eighty, and, recovering from them, lived to above ninety, in good health, and in perfect possession of his faculties.

The convulsions which attend dentition in infancy have been classed by some authors with epilepsy; but I think it very doubtful whether they depend on the same pathological condition; and at any rate a medical man who thus designated such fits would give a great deal of unnecessary pain in a family. But whatever the immediate cause of the convulsions may be, they depend on a very different state of health generally. They require a very different line of treatment. The cause is one which is acting without intermission. It is more decidedly inflammatory, and the antiphlogistic measures which will permanently remove the convulsions of infancy, would, in true epilepsy, render the patient more liable to a recurrence.

Georget* considers the disease more frequent among women than among men; but this does not accord with my own experience.

Many of the higher animals are subject to epilepsy; for instance, the

* Dict. de Médecine, 21 vols., tome viii. 1823, p. 207.

dog, cow, horse and pig. The fits that puppies are subject to are true epileptic fits.

Georget,* though he does not deny the possibility of sympathetic epilepsy, says he has never seen such a case; he avows frankly that he knows nothing of the nature of epilepsy.

Post-mortem examinations have failed to show that epilepsy is dependent on any single morbid condition of either the membranes or the brain.

In most instances, where the disease has existed some time, some morbid alterations have been discovered after death, which may be divided into two classes—those which would act as irritants to the brain, such as osseous deposits on the dura mater, and those which there is more reason to believe have been occasioned by the paroxysms, than that they are the cause of them, such as thickening of the membranes, &c.

Esquirol says,† "Of all these researches, particularly of those of Bonet, Morgagni, Baillie, Greding, Meckel, Sprengel, what are we to consider? Nothing. Wepfer and Lorry have drawn this sad conclusion. Let us avow frankly that pathological anatomy has at present shed but little light on the immediate seat of epilepsy. However, we must not be discouraged; nature will not always be so rebellious to the efforts of her investigators."

In many cases bony deposits have been found on the dura mater, and in some instances even a spiculum of bone has been found projecting from the internal table of the skull. But such morbid growths cannot be considered the proximate cause, as these are always there, whereas the fits come in paroxysms, and leave the patient in the interval quite well.

I quite agree with Dr. Watson when he says, "Dr. Marshall Hall's doctrine, that all convulsive diseases of the spinal marrow cannot be properly applied to this convulsive disease of epilepsy." It is very clear that the brain is always more or less affected in epilepsy; and the milder forms, where there is interruption to the mental operations, but without any convulsion, affords a strong argument in favor of this opinion. All that Dr. Hall has written is worthy of attention; but the more I have seen of epilepsy, the more I am convinced that the brain, and not the spinal cord, is primarily affected.

Dr. Marshall Hall divides epilepsy into two forms,‡ "Centric convulsions, or epilepsy," and "Centripetal epilepsy." Both forms he considers true spinal, not cerebral, diseases; but I will quote his exact words, that I may not misinterpret his meaning, and thus unintentionally do injustice to this able physiologist.

"*Any* disease within the cranium or spine, whether effusion, tumor, exostosis, &c., may induce convulsions or epilepsy.

"Fright, or other sudden mental emotion, has induced convulsion, and this convulsion has been repeated, affording one of the most deplorable cases of epilepsy. I have already suggested, indeed, that *all* convulsive diseases are affections of the true spinal marrow (I refer my readers to previous observations).

* P. 214. † Des Maladies du Cerveau, tome i. p. 313, 1838.
‡ Page 319, op. cit.

"The cerebrum is obviously the seat of the mind; it is neither sentient itself, nor the originator of motions in itself. The true spinal marrow, on the contrary, is the term of certain excitements and the combiner of certain motions—the centre, in a word, of a peculiar series of excito-motory phenomena, physiological and pathological. Unlike the cerebrum, it induces, if stimulated, convulsive movements in the organs appropriated to ingestion and egestion, and in the limbs.

"Diseases within the cranium, by irritating excitor nerves, or the medulla oblongata, induce convulsions or epilepsy, too frequently, alas, of an incurable kind. Disease within the spinal canal may prove the source of convulsion or epilepsy still more immediately. This form of epilepsy is, also, for the most part, incurable. These cases are, for obvious reasons, frequently met with in hospitals, asylums, and workhouses. Hence the idea that epilepsy is not to be subdued by medicine, prevalent amongst those who draw their conclusions from observations made in these establishments."*

Epilepsy induced by external causes, not internal disease, he denominates Centripetal epilepsy.

"This form of epilepsy takes its origin in the *excitor nerves* of the true spinal system, involving the axis of this system and its motor nerves in their turn; functionally, not organically. It is for this reason that I have denominated this form of epilepsy *centripetal*. This form of epilepsy is to be viewed as *curable*, however *difficult* of cure. By avoiding the exciting causes, its attacks are avoided; the susceptibility to returns subsides; these returns become less frequent and less severe, and, at length, frequently cease altogether. Everything depends upon rigid rules proposed by the physician, and *most strictly* and perseveringly observed by the patient.

"In describing the *causes*, *symptoms* and *treatment* of centripetal epilepsy, I must refer to all that I have said respecting the anatomy and physiology of the true spinal system. *Every* part of this system is distinctly but exclusively involved in the circumstances of the disease; if the encephalon suffers, it is only as an *effect* of the convulsive attacks."†

He then proceeds to speak of the causes, detailing, 1, "the presence of indigestible food in the *stomach;* 2, the presence of morbid matters in the intestines; 3, uterine irritation. The first of these acts through the medium of the pneumogastric, the second and third through the true spinal system."

The following facts illustrate many points in the history of this curious disease, which are of importance and interest to the practitioner. The mother of the patient was a particularly intelligent woman for her station in life, and always gave me a very clear account of her daughter's illness. She was a pale, delicate looking girl, intelligent, nervous, and excitable; has suffered from epilepsy for some years. She was a seven-months child, born in 1829, very small and feeble; she was unable to walk by herself till she was two years old, though at that time her articulation was perfectly distinct, and she had abundant power of expressing herself. Her excitability was so great, that any over-amusement or

* Page 319. † P. 322, op. cit.

emotion produced sleeplessness. This, after the first difficulties were overcome, was the great enemy the parents had to contend with. At the age of sixteen months something like a dizziness, quite momentary, appeared. The eye became fixed, with a quick vibration of the head, and a tendency to fall forward, so that at that time if she could have been unsupported she must have overbalanced herself. This, which was for some time only apparent to the mother, increased in degree and duration so much that, at the age of three years, when she was a very lively, talkative child, it became evident to all, for in the midst of her prattle she would frequently stop short, the head would nod forward several times, and sometimes she would fall. The lapse in consciousness was so complete that, though she always recovered herself in a minute with a deep sigh, she never regained the thread of her story, but passed to something else, having forgotten it. These little effects were considerably augmented by emotion, fatigue, or excitement; and this appeared to be the first stage of the complaint.

The second stage arose when she was five years old. The nodding had much increased lately, and now came on what the parents called the seizures, which were an odd state of semi-consciousness, with a great deal of spasmodic motion of the body, inability to direct the eyes to any particular object, or even to fix both on the same thing; a rambling conversation, with a hesitating, tremulous voice, accompanied with many ocular delusions. This state, which came on every few days on first waking, generally lasted about half an hour, though sometimes through the day, and often ended without any fit or crisis. In the second year it assumed a periodical character, returning on the third, and then on the fifth morning. At these times water was passed unconsciously, and the bowels generally moved, before she could give warning. No notice was ever taken to her of these attacks, and great attention was paid to remove from her objects of excitement, and to keep her brain in repose, —and so we come to the third stage.

At the age of seven, the nurserymaid, who was dressing her, suddenly fell back in a strong epileptic fit, which it was impossible to conceal from the child, who appeared deeply affected by it, and on the following morning (which was the day for the seizure) having continued the usual time in her semi-conscious state, instead of recovering from it, she stretched herself, and went off into a fit of the ordinary epileptic character. These fits have now continued for nearly nine years, being always ushered in by the semi-conscious spasmodic state on first waking. Most of the usual remedies employed in cases of epilepsy have been tried, such as Valerian, Copper, Indigo, Musk, and Oil of Turpentine, all with some good effect for a time; Indigo and Oil of Turpentine with great success, particularly the latter, till she became quite accustomed to it, when its efficacy gradually wore away. The symptoms which indicate the fit generally appear on the preceding day, consisting chiefly of a rapid quivering of the eyelids, nodding of the head, with lapse in conversation, sometimes pain in the forehead; but if this last increases to a real headache, so as to end in sleep or in vomiting, the next day's fit is generally averted for three or four days at least, sometimes for a longer period; she has, in consequence, frequently had given her an

emetic under these threatening signs, and with success. Four or five weeks may perhaps be considered as a fair average duration for the interval between the fits; towards the latter part of that time the irritation has been very visibly accumulating, though often disappointed, as it were, by the emetic or blister behind the ear, till it has become uncontrollable, and has ended in a fit. The fit leaves no cloud on the mind, but a great languor of body for one or two days, after which all nervous susceptibility seems quite gone. For a week, at least, all vibration of the eyelids is quite suspended, and the mind appears to be perfectly calm and free from excitation. On eight different occasions she has lain in convulsions for three hours. These attacks have not begun like the common fit, which is with a scream, and struggle to turn on the face; they have generally set in with strong movement in one arm, which is lifted above the head; they have been preceded by the usual semi-conscious state, and, during the last half hour before the convulsion began, by an apparent insensibility, when the saliva has bubbled from the mouth, and the hearing has seemed quite gone. During the whole time that these convulsions have lasted, the heart has beat violently, the face has been suffused with red, and the lips purple; during the three hours the convulsive agitation has been incessant, growing fainter, till the poor child has at last sunk exhausted to sleep, but not till the struggle for breath and the apparent thread of suffocation were frightful to see. She has had no such severe attack for four years.

On eight other occasions she has lain in the semi-conscious state through two successive days; sometimes the fit has closed it, and sometimes natural sleep. It is also a long time since she has had an affection of this kind.

The pulse always increases steadily in frequency from its ordinary rate, about 70 in the minute, up to 90 or a 100, previous to the attack occurring. I ordered the digitalis in this case with apparently some benefit, but I have since lost sight of the case.

In the treatment of all disease, we ought to have some distinct idea of the pathological condition on which it depends. In many diseases it is extremely difficult to come to any satisfactory conclusion, but still it is our duty to attempt it. Before we consider the treatment of this disease, I will theorize a little on its pathology. In detailing the following theory, I am too well aware that it does not deserve a higher title than a *theory;* I do not pretend that it has originated with me, though I know not on whom to father it.

The first morbid action is a sudden determination of blood to the brain, which expends itself, in the secretion of that nervous power which, in a state of health, is employed by the brain to convey volition to the muscles, and which power is, I have no doubt, identical with electricity. This excessive secretion is carried off by the motor nerves, like a discharge from an electric battery, and, from its quantity and excess, produces excessive action of the muscles. It is another illustration of a law that we had occasion to decide upon already, namely, that the first effect of arterial excitement in every secreting organ is to excite to an unnatural degree the natural function of the organ. We know that mental emotion will cause a sudden determination of blood to other

organs, which, according to the nature of the part, will be followed or not by secretion.

Blushing and erection of the penis are instances of sudden determination of blood to a particular part. And the lachrymal glands, salivary glands, testicles, prostate gland, gastric glands, and even the kidneys, often pour fourth their secretions so abundantly and so suddenly that the formative fluid, the blood, must have circulated through their capillaries in greater quantity and with greater rapidity than when the glands were at rest, and their secretions suspended. I think that the periodic attacks of mania, with which many of the insane are afflicted, may be regarded in this light.

Since writing the above, I have met with the following observations of that excellent physician, Dr. Alison, which I am delighted to quote in support of my views, though it may deprive me of any credit of originality.*

"There are hardly any chronic local diseases in which local determinations and congestions of blood do not occur; and we are not sufficiently informed of the cases in which such irregularity in the distribution of the blood may be regarded as the primary or fundamental morbid change. Probably these cases are in reality few, but it is important briefly to enumerate the principal diseased states in which morbid determinations of blood certainly occur, and in a great measure determine their extent and intensity, and injurious results. Thus, very various derangements of the functions of the nervous system, headaches, giddiness, transient imperfections of sense, or of memory, fits of epilepsy, of hysteria, or other spasms, even of mania, in those predisposed to these diseases. Some cases of transient paralytic affections, and many of apoplexy, appear to result from simply increased afflux of blood to the brain, without rupture of its vessels, disorganization of its texture, or even increased effusion of its serous fluid."

The vessels, which are especially the seat of this morbid action, I suspect, are those of the choroid plexus, and one of the layers of the cortical substance. The choroid plexus is frequently found hypertrophied in the brain of epileptics, assuming an almost fleshy appearance. This hypertrophy would, very probably, be the effect of repeated action. It is also the seat of small tumors, generally like hydatids.

The expression "determination of blood to the head" is often made use of, but without any explanation of the manner in which this takes place. I doubt whether the profession generally have any distinct idea as to the exact condition of the vascular system which produces it. I would venture to offer the following theory, the first idea of which I certainly derived many years ago from that most truly philosophical work, the Elements of Physics, of Dr. Arnott. It applies not merely to the head, but everywhere else. The middle or muscular coat of the arteries in a state of health, contracts with each systole of the ventricles just sufficiently to give a solidity to the wall of the pipe, so that the force of the contraction is not lost on a yielding surface. A much greater force is required to drive water through a leather hose than through a leaden tube. The middle coat contracts just sufficient to assimilate the artery

* Alison's Pathol., p. 554, op. cit.

physically and temporally to the *leaden* tube. Arteries with permanently rigid walls, like leaden tubes, would have interfered by their rigidity with the motions of the limbs; and hence this beautiful contrivance. When this middle coat does not contract, or only contracts imperfectly, then the force of the heart dilates the tubes, and produces congestion.

I believe, then, that determination of blood to the head arises simply from deficient contraction of the muscular coat of the capillaries of the brain, preceded by excitement of the heart's action.

The throbbing of the carotid arteries may be considered as corroborative evidence in favor of this opinion. The throbbing cannot arise from *action* of the vessel; it is the *action* of the heart *felt* strongly, and *seen* distinctly, because the tube *yields* to the impulse of the left ventricle, instead of resisting it, like a solid leaden pipe. If the throbbing arose from the action of the artery, it would not be synchronous with the heart, which it is. It is the same yielding of the coat of the capillaries in an inflamed limb which gives rise to the throbbing sensation, which all of us have felt in some small spot or another.

I think it not at all improbable that the reason why these capillaries of the brain thus suddenly and unnaturally neglect to perform their duty, is some defective innervation from the sympathetic nerves, whose office I hold to be the regulation of the coat of the arteries, so as to produce secretions, &c.; and so far, I can see much probability in the opinion of the Wenzels, that the pituitary gland is in fault in epilepsy—believing, as I do, with Dr. Copland, that this gland is the cerebral ganglion of this nervous system.

The following are Dr. Copland's words in reference to apoplexy:* "Upon tracing the relation subsisting between the various causes of the disease, the symptoms, and the appearances on dissection—upon remarking as far as my own observation has gone, the frequency of change in the pineal and pituitary glands of apoplectic patients—I am induced to infer that functional lesion, or organic change, often commences in that portion of the ganglial system which supplies the encephalon and its blood-vessels; and that, owing to exhaustion of its influence, the capillaries lose their vital tone, have their circulating functions impaired, become more or less dilated, and are disposed to rupture."

The invaluable researches of Dr. Burrows have shown that the vessels of the brain may contain a larger quantity of blood at one time than another, just as the vessels in any other part of the body may be so affected.

Dr. Bright says,† "There is no organ of the body liable to such rapid, violent, or frequent changes in the state of its circulation, as the brain; and while the excitement to which other organs are exposed is in some degree limited, those which act on the brain seem to be almost unlimited, augmenting with every increase of luxury and civilization." "It is impossible for us not to feel admiration at the wonderful power of resistance by which the brain is daily preserved from disorganization, when we consider the intensity of mental application to which it is exposed, the violence of internal strife by which it is agitated, the heed-

* Dict., vol. i. p. 97. † Op. cit., p. 653.

less stimulation to which its vessels are subjected, and the rapid vicissitudes of temperature, and the severe and neglected external injuries to which it is liable."

There are many circumstances attending organic disease of the brain, which I think can only be accounted for on the supposition that the quantity of blood in the brain varies very much at different times. One of the most striking of these is the remission of pain, and accession being produced by anything that would tend to accelerate the circulation. In the following quotation from Dr. Abercrombie, I have put in italics those phenomena which appear to me to support this view of the subject.*

"The pain is in some cases acute and lancinating, in others obtuse; and it is sometimes referred to a particular spot, as the crown of the head or the occiput. In many cases it is accompanied by a *violent throbbing*, and this also may be general, or it may be referred to a particular part of the head, as the occiput, or one temple. In the more violent paroxysms the pain is intense, obliging the patient *to remain for a considerable time in one position, the slightest motion aggravating it to perfect torture;* but the remissions from this severe suffering are often so remarkable as to lead a superficial observer into the belief that it is merely periodical headache, or headache connected with dyspepsia. This latter supposition is also countenanced by the stomach being frequently much disordered, and by the more violent attacks being often accompanied by vomiting. The diagnosis, indeed, is sometimes difficult, but, by attention, it will be found that the duration and violence of the pain must lead to a suspicion that the complaint is something more than common headache, and that though the stomach is at times disordered, yet that the headache is often most severe when no disorder exists in the stomach that can account for it. The patient generally *cannot bear a warm room, the noise of company, or even the exertion of cheerful conversation, without becoming distressed and his headache increased; and the same effects are produced by wine and bodily exertion. He seeks quietness, coolness, and darkness; and in these respects the disease differs remarkably from dyspeptic headache, which, is commonly dissipated by exercise and cheerful company.* Sometimes the paroxysms are accompanied by vomiting, and sometimes *by violent throbbing in the head.*"

Most authors who have written on epilepsy agree in stating that the brain is in a state of congestion during the fit.

Esquirol says,† "Sanguineous plethora has been admitted by all authors as a cause of essential epilepsy." Foville states that the brain of patients who have died in the fit is always found congested; but he attributes it to the mode of death, which he considers from suffocation; and that the same appearances are found in persons who have died by hanging; that they are not peculiar to epilepsy; and that they do not explain the attack, but only point out the way in which it has been fatal. Upon this Dr. Watson remarks,‡ "It is, I fancy, a very common notion, both that such congestion does take place, and that it is the cause of the paroxysm."

* Abercrombie, op. cit., p. 317. † Op. cit., tome i. p. 307, 1838.
‡ Lectures, 2d edit., 1845, vol. i. p. 617.

Dr. Watson does not agree in this view, and for the following reason :— "In the first place, it is not easy to conceive that the congestion could so suddenly arise and subside again, as it must sometimes do, if it be the immediate determining cause of the fit, within the space of a single minute, for example. In the second place, the signs of external congestion and plethora, by which signs we measure the amount of the *internal* or most marked, just when the symptoms of the paroxysm begin to subside and disappear, so that we cannot look on the congestion as a *cause* of the convulsive symptoms." In answer to the first, I would suggest that, as it is not owing to venous congestion, but to arterial, it is quite possible that this should subside suddenly, supposing the blood to be employed in the arterial capillaries in the secretion of the power (whether the electric fluid or not) which is suddenly discharged by the nerves into the muscles; and in regard to the second, I think that the congested state of the venous system, after the convulsive explosion has taken place, can only be caused by the flow of blood from the arterial or secerning system. Dr. Holland considers this condition of the arteries, which I believe to be the immediate cause of *determinations* of blood, dependent on nervous influence. He says, "I find among my notes many instances of partial change in the arterial circulation; some in which the effect was manifest even in the larger arteries, leading to a part under this influence."* "An example has recently occurred to me of slight hemiplegia evidently connected with cerebral disease, where the beat of the arteries on one side of the head was wholly different in character from that on the other, as shown even in the carotid itself; and similar differences probably exist in many cases of this nature. The strong beatings which sometimes occur in the course of particular arteries are well known; and though we may hesitate to describe them, with Laennec, as neuralgic spasms of the artery, yet it is difficult to attribute them to any other than nervous influence, of some kind, on the coats of the vessels so affected."†

With regard to the cause of epilepsy, Dr. Copland thus expresses himself:‡—

"That in the simple and early disease it is not dependent upon any lesion cognizable by our unassisted senses, unless such lesion be seated in the *medulla oblongata* or *pituitary* and *pineal glands*—parts not yet sufficiently examined in this malady, and which may be dangerously affected, without manifesting any material change. That the appearances found in old or complicated cases are to be referred rather to the repeated derangements the circulation of the brain has suffered in the paroxysm, and to the nature of the associated disease, than to the lesions detected in fatal cases; such lesions, however, when induced in the course of other disorders, being occasionally exciting or concurrent causes of the epileptic attacks. That general congestion of the encephalic vessels evidently exists in the second or convulsive stage of the fit; but it is not so manifest that this state is present from the commencement of the seizure, as cases have presented, at this period, symptoms of a very opposite condition. This congestion is only a passing phenomenon, evi-

* Med. Notes and Reflec., 533. † Op. cit., p. 540. ‡ Med. Dict., p. 797.

dently caused by interruption to the respiratory actions, impeded circulation through the heart, and to the spasmodic action of the muscular system, and is not the cause of the seizure; the principal phenomena of the fit even ceasing at the very moment when the congestion is at its height. The paroxysms of epilepsy cannot, therefore, be imputed to the congestion, which is evidently an advanced or consecutive phenomenon produced as now stated, but must be referred to the parts on which sensibility depends, and which actuate the respiratory and muscular organs."

"Congestions of blood do not occur; and we are not sufficiently informed of the cases in which such irregularity in the distribution of the blood may be regarded as the primary or fundamental morbid change. Probably these cases are in reality few, but it is important briefly to enumerate the principal diseased states in which morbid determinations of blood certainly occur, and in a great measure determine their extent and intensity and injurious results. Thus very various derangements of the functions of the nervous system, headaches, giddiness, transient imperfections of sense or of memory, fits of epilepsy, of hysteria or other spasms, even of mania, in those predisposed to these diseases, some cases of transient paralytic affections, and many of apoplexy, appear to result from simply increased afflux of blood to the brain, without rupture of its vessels, disorganization of its texture, or even increased effusion of its serous fluid."

My own observations do not accord with Dr. Copland, in so far as I have always witnessed a flushing of the face previous to convulsive paroxysm, previous, as I believe, to the discharge of the electric fluid in those epileptics who were full blooded and plethoric. In the very feeble and asthenic, I suppose that the surplus quantity of blood has not been sufficient to overcharge the brain and *flush* the cheeks at the same moment.

The amazing benefit which I have seen derived from the use of digitalis, as described under the head of "Treatment," is strongly corroborative of this theory. This powerful medicine was most serviceable when it kept the pulse down even below the standard of health.

The following case I have selected, as most illustrative of this view of the subject, inasmuch as our patient had only two complete fits after commencing the digitalis, though previously he had two or three during one day in each week. The half attacks gradually disappeared also. The pulse, which, previous to the exhibition of the digitalis, was quick and very irritable, was kept down by this medicine to 54 in the minute; seldom above this, sometimes below.

Case 79.—C. S. G., æt. 19. Fresh complexion, healthy looking, steady habits, neither addicted to masturbation nor venery. Consulted me February 3d, 1845, for epilepsy. About June, 1843, he had a severe mental impression from reading "Diary of a Physician"—depressed. In Oct. 1843, he lost consciousness when playing at Loto, but without any fit: this half attack occurred nearly every day until he had his first fit, which happened on the 27th February, 1844, between one and five in the afternoon. He had another on the 10th May, another on the 11th November, one on the 9th December, and on the 20th January he had two, between one and five in the afternoon. His father had been dead some years: two or three years previous to his decease his powers of mind became weakened so much as at last to incapacitate him for business: he had two or three attacks of fainting, attended with partial paralysis; his last and fatal attack lasted only for two or three days. *Post-mortem* showed a colorless state of the brain, with softening, and a few ounces of fluid in the ven-

tricles: his symptoms during life were attributed by his medical attendants to ramollissement.

February 3d.—The attacks have lately come on more frequently, generally exhibiting a sudden loss of consciousness and memory for a short time, then recovering also suddenly. He generally turns pale, his lips blue, and his hands sometimes slightly convulsed; sometimes one, sometimes two, attacks of this kind in the day. I ordered him to take Argent. Oxyd. gr. j. b. d. Ext. Col. co. gr. v. o. n.; and on the 3d of March to take it three times a day with gr. ij. of Ext. Col. co.; also Liq. Potass. ℥ifs. Tinct. Iodinei co. ʒj. Sp. Æther. Nit. ℥ifs. Capt. coch. min. ex aquâ. b. d.

March 1st.—Had a decided fit while walking with his mother—was in a state of unconsciousness for several minutes previous to the fit. There was no flushing of the countenance, no cry, countenance blue during the fit, but soon recovered its color, the struggle was not severe, and did not last long. He remembered everything before it occurred, does not believe it was so severe as usual, slept for an hour on his arrival at home.

April 7th.—Has been going on much the same, the attacks increasing rather in frequency than otherwise. Ordered—continue Argent. Oxyd. The attacks still increased rather in frequency, if not in severity, till the 27th June, 1845, on which day he went to stay with Mr. B. in the country. To take Argent. Oxyd. gr. j. Ext. Col. co. Ext. Gentian. co. gr. iifs. ft. Pil. ij. t. d., and an aloetic pill at bed-time. The imperfect attacks generally occur three times, sometimes four or five times a day.

August 14th.—Had a complete attack at 1 P.M.—lasted a quarter of an hour, attended with great frothing at the mouth, with considerable congestion of the head and face, not followed by any coma. Has always three partial attacks in a day.

23d.—Has had no fits for four days; this morning at 10 A.M. he had an attack, limbs rigid and strongly convulsed—lasted about ten minutes. Had another attack of the same duration at 6 P.M. soon after dinner, strong convulsions, lividity of features, intense action of carotids. Was yesterday subjected to a little excitement from a visit home. A leech was applied to the nostrils. Pil. Hydrarg. Ext. Col. co.

August 25th.—Argent. Oxyd. Zinci. Oxyd. gr. j. Ext. Col. co. gr. iifs. ft. Pil. t. d. s. App. Lin. Tinct. Iodinei. c. Liq. Potassæ.

31st.—Has had three half attacks daily, but they are less severe; at the present time he is rarely insensible during their continuance, and is conscious of their existence.

September 5th.—Five attacks yesterday, with symptoms of indigestion.

15th.—Better: attacks slighter and less frequent.

29th.—Heavy and low spirited: a leech has been applied to the nostril occasionally, and with benefit.

November 2d.—Still has four attacks daily, though not so severe.

6th.—A complete attack with convulsions, but short. Two half attacks in the evening.

11th.—Three half attacks daily. Zinci Sulph. gr. ij. Conf. Rosæ. q. s.

29th.—He continues much the same, general health pretty good, sometimes three, sometimes even five, half attacks per day; three every Sunday. To-day he was ordered to omit the pills and commence taking Inf. Digitalis ʒj. every night.

Jan. 4th, 1846.—Four half attacks daily, two complete to-day. These two are the last he has had.

6th.—Dose increased to ʒifs.

9th.—Three half attacks, pulse 84.

10th.—But one half attack.

15th.—Has had three per day lately, to-day but one, silent and depressed, pulse 78. Omit for two days.

16th.—No half attack.

19th.—Dose has been reduced to ℥i.; no attack.

27th.—Has had no attacks at all since last report, but has had four half attacks to-day.

28th.—Five; ʒx.

February 1st.—None; pulse 58. Has had some sickness, which has gone off.

6th.—None.

7th.—None: very sick: omit medicine two days.

10th.—Three half attacks.

18th.—None; has had one daily for the last few days.

27th.—None; pulse 84. Irregular. Dose ℥ifs.

March 1st.—No attack, general health excellent.

6th.—Has had one yesterday and to-day.

24th.—Has had some days one attack, on others none during the day. Had a half attack to-day. Pulse averaged from this date 54 in the minute until he left off the digitalis.

June 13th.—Has left the country; has not had any attack since the last report: takes ℥ij. o. n.

June 1847.—Continues perfectly well; has not had any more attacks, nor taken any of the

medicine since the 15th of August; having occasionally previously intermitted its use. Is now regularly occupied in business, active, and healthy in mind and body.

In another case, the subject also being fresh complexioned and of sanguineous temperament, the fits were arrested for six months by the action of the digitalis. Previous to its use he had suffered generally every ten or fourteen days, then having four or five fits in forty-eight hours. After the commencement of the medicine, he only had one, and that very slight. This young gentleman had a constant redness of the skin above the eyebrows, which always became more vascular at the period of the attacks. When the attacks were arrested by the digitalis, this redness disappeared. He left town, and when away, the medicine was not continued so regularly, and the redness returned, and with it the attacks, though they came singly, and only two in number—the digitalis again controlling them.

I believe that in all cases of fatal epilepsy, where there has been an autopsy, the vessels of the brain and membranes have been found enormously distended, and in some there has been extravasation.

The *Œnanthe crocata*, or hemlock water-drop-wort, when taken in any quantity, produces epileptic convulsions. I was present at the *post-mortem* examination of four convicts, who died at Woolwich from eating it. The progressive amount of sanguineous effusion on the brain was in proportion to the length of time they survived. The seizure was most striking and instructive.

In all there was great congestion and some sanguineous effusion on the surface of the brain: in those that lived the longest, the quantity was in proportion to length of time they survived the seizure. The first man died in about an hour, and the last in about two hours.

The following case appears to corroborate this idea, that the proximate cause of the convulsions is a *rush* of blood to the brain, if it may be so expressed.

Case 80.—*Ligature of the common carotid in epilepsy.*—Michael Cox, pensioner, æt. 25, sanguineous temperament, and muscular.—This man has for the last five years been subject to very severe epileptic fits, recurring generally about once a fortnight. He was first attacked whilst on duty at Burmah, but without any previous warning, and without having experienced any attacks of illness. He had, however, for some time been much exposed to the sun, and undergone great fatigue. He had lived generally temperately. Since the first seizure, the epileptic fits have generally recurred without any assignable exciting cause, but have been also occasionally induced by intemperance. He has not been able, however, to take by any means the same quantity of spirits or other intoxicating liquor as European soldiers generally do; a very small quantity comparatively completely overpowering him, inducing extreme giddiness, and violent throbbing headache. He had been frequently bled during the paroxysms, but subjected to no other treatment. The first time the fits were particularly brought to my notice, was whilst he was attending a hospital as orderly over one of the sick. The attack was extremely violent, and his efforts so powerful, that it was with difficulty he was restrained by several persons. There was great cerebral congestion, a feature which I conceive essential to every attack of epilepsy, and by preventing which (an object I believe attainable by tying one or both carotids) I hope to cure the disease. Still my expectations of success did not rest entirely upon the correctness of this view of its nature, which might, I was aware, be erroneous, but yet the epileptic tendency be removed by the operation, although in a manner different from that expected by me.

The operation was performed on the 4th February; the ligature came away on the 5th March.

April 13th.—Since the operation was performed, there has been no return of the epileptic attacks, nor any tendency to them. He has experienced also, since that time, a great improvement in his general health and feelings. His spirits have been good—before almost

constantly depressed, and he could not stoop for any time without giddiness and consequent danger of falling. On this account he was not able to work at his trade—that of a shoemaker—and was obliged to abandon it. Since the operation, he has again resumed his work, and has not experienced the least return of these disagreeable feelings. He has also proved the efficacy of the remedy that has been employed by very hard drinking, which he and his friends considered a test; it required a large quantity of spirits to make him drunk, and he did not afterwards experience the headache, and gloomy and even horrible feelings, which had previously always followed such an excess. He suffered, as he told me, scarcely at all. His whole feelings have undergone a complete revolution, and he is now as happy as he was before miserable and wretched.

The warning which I have already adverted to, which many epileptics have, viz., a singing noise in the ears, I believe arises from the dilated carotid artery vibrating in the carotid canal close to the vestibule of the internal ear. I regard it as analogous to the throbbing produced by the dilated artery in an inflamed part. If this hypothesis is correct, it may be considered an additional argument in favor of this theory.

Dr. Conolly* observes that epileptic patients are occasionally warned of the approach of a paroxysm by mental excitement, their high spirits becoming to their friends the well-known precursors of their sufferings. This must arise from arterial action. It is analogous to the mental excitement induced by spirituous liquors; no one doubts that this psychical effect is produced by a physical cause.

In reference to a theory which was broached by the Wenzels, that the pituitary gland is always diseased in this complaint, Dr. Bright says,† "Much importance had been ascribed to that organ as connected with epilepsy; I have not, however, as yet succeeded in tracing this connection. Indeed, the structure of the gland is very apt to deceive us as to its changes; for in its healthy state it is a firm, fleshy body, so sunk in the sella turcica, that often, in attempting to bring it into view, we lacerate or injure it. Still, however, there is no doubt that it is sometimes out of proportion, small and compressed; at other times larger than we should suppose healthy; sometimes the seat of small excavations, and even of suppuration; and in one case mentioned in the present volume, it was supposed to be altogether wanting. It is by no means impossible that it may want some peculiar influence in epilepsy; but I have undoubtedly seen epilepsy where no obvious disease existed in the pituitary gland; and I have seen cases where it might be well supposed to be small and dwindled, but this depending entirely on that frequent occurrence in epilepsy—the thickening and morbid growth of the processes of the basis of the skull."

Dr. Bright says, "I believe that almost always during the epileptic paroxysm either as a cause or an effect, sanguineous congestion takes place within the brain."

Continued cold weather sometimes induces epilepsy in old and feeble constitutions. I suppose it is by disturbing the circulation that it produces the fit. I believe that the severity of the weather last winter brought on several severe forms of cerebral disturbance.

Case 81.—February 1st, 1847, I was called in great haste to visit a gentleman, aged 56 years, though in appearance much older. I found him standing in his counting-house with

* An Inquiry concerning the Indications of Insanity, by John Conolly, M. D. London, 1830, p. 241.

† Op. cit., vol. ii. p. 696.

a vacant look, and apparently lost to all surrounding objects; bis eyes were opened, and pupils quite natural; he was unable to answer any questions; his face and hands were cold, and head rather bot; the pulse was small, feeble, and about seventy. I tben beard the following history: Shortly after coming to town in the morning, his partner observed he did not seem quite so clear-headed as usual. This dullness of intellect gradually increased, until his partner became alarmed, and thought it necessary to have medical advice. I learnt that his general habits were quiet and penurious, living rather below par than above: it was very clear to me he would not bear any depletion. I was anxious, therefore, to put his feet in hot water, and to get him to bed as soon as possible; but before I could get him into a cab he was seized with an epileptic fit; it was preceded by a short cry and accompanied by the usual convulsions, wbicb did not affect one side of the body more than the other: be remained quite insensible about a quarter of an hour, and tben very slowly recovered his consciousness; but before this took place he was lifted into a cab, and I proceeded to his home, in the neighborhood of London; by the time he had arrived there, he had so far recovered himself, that he soon recognized his own house, and he said something, though very indistinctly, to that effect: as soon as I got bim into the house, I ordered his bed to be warmed, and mustard poultices to the calves of his legs, his feet to be immersed in hot water.

I sent for his usual medical attendant, who agreed in the view I had taken of the treatment required. Our patient soon recovered his entire consciousness, after the general warmth of bis body was restored. We gave him some cal. and rhubarb that night, followed by a purgative draught: he gradually recovered, but for some weeks suffered much from great debility of the lower extremities. He is now pretty well, though he does not feel his mind capable of much attention to business. The rest of our treatment consisted at first in simple, bitter infusions, until the tone of the stomach seemed restored; afterwards we gave him the bichlorid. of mercury in sarsaparilla. The latter medicine was given in consequence of the partial paralysis of the lower limbs. He has had no more fits.

The remote *causes of epilepsy* are very uncertain; but there is one to which our attention should be directed—I mean the venereal disease. Every practical surgeon knows how often this poison puts its paw upon the dura mater. We have already had occasion to consider this. Syphilitic inflammation in the fibrous tissue not unfrequently produces deposits and thickening; and more than once have I seen epileptic fits apparently result from the irritation which this disease occasions. My attention was first called to this fact by my friend Mr. Thomas Copeland, a surgeon, who related to me a case of the kind which was cured by active salivation. The following case occurred in my own practice, and was clearly dependent on periosteal mischief, though its syphilitic origin was not so clear. It is another case in illustration of the value of the tincture of iodine in cerebral affections.

Case 82.—*Affection of the periosteum of the skull and membranes of the brain.*—May, 1843, A. B., a married gentleman, æt. 27, consulted me with the following symptoms: deafness in both ears, occasional feeling of giddiness, more in the morning than in the evening; but he soon feels tired from exercise, and then he has a throbbing in his head, and feeling as if he was going to be giddy. He has no decided pain in his head, but he feels very uncomfortable, has occasional retching, but does not bring anything off his stomach.

Complexion yellow; pulse 100, weak and irregular; tongue rather pale, but not furred; fauces slightly injected; he has occasionally twitchings of the arms on dropping off to sleep, but not more on one side than the other. He showed me four periosteal swellings on the head, two on the left side of the forehead, another on the rigbt side, and a fourth over tbe mastoid process of the temporal bone on the right side: all these contain fluid.

History.—Had sypbilis seven years and a half ago; took a little mercury, but neglected himself; had secondary symptoms, which were efficiently treated by an intelligent practitioner with the oxymuriate of mercury and sarsaparilla; be got quite well, and is quite certain that he has not had any symptom, of any kind, of this disease since. About three years ago be was thrown out of his gig and pitched upon bis head, by which he was rendered insensible, and on recovery found himself deaf, from which he bas suffered ever since.

Ordered him a little blue pill and rbubarb at night, and draught in morning.

7th.—Potass. Iodidi gr. iv. bis die. Sarsa. bis t. d. Hydr. c. Creta gr. ij. Pulv. Rhei gr. j. o. n.

13th.—Head shaved, Tinct. Iodine to the head.

18th.—Decidedly better, and went out of town.

24th.—Ditto, less giddiness, no sickness, appetite good.

June 13th.—Complains of some heat in his head: to leave off the Iodine, and use a cooling lotion.

20th.—He feels so perfectly well that he determined to go back again to his business; he can walk six or seven miles without inconvenience.

Ordered to take the Iodine and Sarsa. once a-day and the pill at night.

His place of business is hot, and he feels the writing so much that he is obliged to give it up again: he remained a week sleeping out of town, but he found it was of no use.

July 3d.—When he returned to me, he complained much of pain in his head, and twitchings at night. I ordered him an active purge, three leeches to the head over a spot where he has a fixed pain. Afterwards Hydr. c. Creta gr. iv. o. n. With this plan he soon got much better again.

13th.—Feeling much better, but weak—weaker in the morning than after he has been walking.

August 17th.—Has been down in Kent, living very quietly, continuing his medicine, Dec. Sarsa. c. Iod. and Hydr. c. Creta. Says he is decidedly better; walked up to town from Blackheath, and will walk back again: applied some more Tincture of Iodine to the head.

September 5th.—Much the same, feels pretty well, but says there is a certain feeling in his head which is not quite right: ordered him to resume the use of the Tincture of Iodine to the head.

22d.—Says he is decidedly better, that his hearing has improved wonderfully, and very little feeling of weight in his head.

October 12th.—Says he is perfectly well when he keeps quite quiet, but with any extra exertion he feels a slight uncomfortable sensation about his head. He continued the Tincture of Iodine till within a few days ago, when he thought there was a little heat in his head; he continues the Hydr. c. Creta gr. ij. alt. n. Mist. Iodin. and Sarsa. once a-day. Ord. Hirud. ij. vertici appl. alt die. Hydr. c. Creta om. nocte.

17th.—Much better: he has been applying two leeches every other night to the upper part of his forehead by my advice, on account of a slightly uncomfortable feeling, occasionally at the vertex, when he attempted to read. This feeling he says seems to come on from any slight annoyance which irritates him.

November 6th.—Better, but has still a slight feeling at the top of the head if he reads; it extends, in a zigzag line, as if there had been a cut there, but not over a large surface as before. Ordered to apply Hirud. ij. alt. nocte.

24th.—Has lost everything like pain or uncomfortable feeling in his head, but he had a sensation of giddiness on the 22d, on getting off the coach and walking down the hill; he was rather exhausted, not having had his regular meal in the middle of the day; had a slight tremulous and faint feeling yesterday.

Ordered to leave off his Sarsa. and Hyd. c. Creta, and take Zinci Sulph. gr. ij t. d.

29th.—Still uncomfortable in his head from a feeling of weakness and giddiness. Ordered Pil. Rhei Cal. gr. x. H. S.

December 1st.—Has acted very powerfully, his head is more comfortable, but a feeling of great weakness; the hearing has never retrograded at all.—Ordered Mist. Camph. c. Quin. Pil. Hydr. gr. ij. o. n.

8th.—Better, but not well; to return to the Iodine Potass. Iodin. ex. Sarsa. bis in die, and to go for a fortnight to the sea.

28th.—Says he is now quite well, that after being two days at the sea, he felt all his uncomfortable feelings leave him. He has been stopping a week at Blackheath, and has continued well.

1845, June 15th.—I was sent for during the night to see Mr. ——. When I arrived at 3 A.M., I learnt that he had had nine fits close one after the other, the first occurring about ten o'clock in the evening: he was sensible, and knew me when I came in. I learnt that he had been free from all attacks for twelve months, and had been in very good health, and getting stout; that he had been very regular in his habits, and very strict in his diet; but taking bitter ale every day. That latterly Mrs. —— had thought him not quite so well; that he had been restless at night, and his nose inclined to bleed. The weather has been very hot lately, and the day before he went down to Gravesend with his brother; on this occasion he drank a pint and a half of bitter ale—that is, about half a pint more than usual. I found his head hot, but he did not complain of pain except when he raised it from the pillow. I put his head over a basin, and poured cold water upon it, gave him five grains of calomel, ditto of Rhei and Jalap, and a draught in the morning: he had had a mustard emetic.

16th.—Going on well. I ordered Liq. Am. acetatis and Tinct. Lyttæ, &c. No beer or other stimulus.

18th.—Going on well: to take the Argent. Oxyd. gr. j. t. d.

23d.—Free from all pain, and is quite comfortable; he came to see me.

When epileptic fits once occur in the adult, they are seldom checked at once, generally recurring after a short interval, and our prognosis ought to be very guarded and on the whole unfavorable. But sometimes they occur singly, or limited to two or three, and never reappear; but this is the exception to the rule.

Case 83.—In the month of February, 1843, I was sent for, suddenly, to visit a gentleman who was reported to have had a fit. I was at his house within an hour from its occurrence, and I found him quite sensible and free from pain, both in the head and elsewhere. His brother, who was with him, then informed me that he had been complaining that he was not quite well, having a good deal of pain in the lumbar portion of his back, which he suggested might be disease of the spine, and begged his brother to feel it; on doing so, he winced when I touched a particular spot—which gave rise, as it were, to a sensation which ran up from this spot to the back part of the head, and thus extended over the head—to lose all consciousness, and would have fallen, if his brother had not caught him.

His brother described his condition as exactly the same as an ordinary epileptic attack, of which he had seen many, as Mr. H.'s father had suffered from them for years. He was slightly convulsed, but not much. Before he quite recovered, he opened his eyes with a stupid stare, looking quite unconscious. This attack was soon followed by another exactly similar to that he had two hours before I saw him. Ordered—A draught to be taken at once: Sp. Amm. Ar. ʒſs. Tinct. Rhei ʒj. Inf. Aur. ℥j. and two pills at night; Pil. Rhei co. gr. v. Pil. Hyoscy. gr. v., and to keep in bed till I see him next day.

18th.—Motion full of bile, and healthy; says he feels comfortable; pulse 80, regular, of fair power; examined the spine—could not detect any symptoms whatever of disease. Ordered—Inf. Aurant. co. ℥vſs. Sp. Amm. Ar. ʒſs. Sodæ Carbon ʒj. Tr. Rhei ℥ij. Mf. Mist. cujus cap. sextam partem bis in die.

I attended him for about a month, prescribing for him, after I got the digestive organs into order, the Sulphate of Zinc: this he took for about a month, and then left it off. He has been very careful in his diet, and abstemious in regard to wine, almost abstaining from the latter, which he used to indulge in before, though never to intoxication. He was living, at the time, in rather a low and damp situation, which I persuaded him to quit. He has since lived in a high and dry spot, and has remained perfectly well ever since.

Cases of epilepsy combined with hysteria are generally more tractable than other forms, and yield frequently to very simple treatment; the following was one of this class.

Case 84.—Eliza Tittensor, æt. 20, lives at home—domestic occupation; healthy appearance.

First fit last Christmas, occasioned by fright from a tipsy man, lasted four hours; health previously very good, not subject to headache or any other ailment.

March.—Fit about two months after the first, occasioned at chapel by a man praying very loud near her.

September 23d.—Third fit to-day; no particular cause; complains of her head never having been comfortable since the first fit. Made an issue with Potassa Fusa in the neck. Pil. Rhei c. Cal. gr. x. H. P. mane.

October 16th.—Argent. Oxyd. gr. ij.

23d.—She complained of her head so much, and as I felt it arose from the stomach, ordered Inf. Cinchon. ℥vj. Tinct. Rhei ℥j. Pot. Carb. ʒij. Acid Hydrocyan. dil. ℈j. Sp. Menth. Pip. ʒj. Coch. Magn. ij. bis die.

November 29th.—Much better, free from fits, head easy.

December 18th.—Has continued the mixture regularly, free from headache, feels well, pulse rather small and quick, excitable. She says that on the 14th she sat up all night with her aunt's baby, and that on the Sunday evening she felt as if a fit were coming on, the sensation being a rising in the throat, but she went to sleep and no fit occurred.

January 27th.—Not quite free from headache, but always finds the medicine relieves her head; had not had any fit since the 23d.

February 8th.—Complains much of her head, has not had any fits since. Ordered Zinci Sulph. gr. ij Ext. Aconite, gr. j. t. d. This produced sickness, but relieved the head: to take gr. j. Zinci Sulph.

20th.—To leave off the pills and take the mixture again, which she continued till March 15th; left off all medicine, and dried up the issue: continues quite well.

I received a letter from the medical man of the family, stating that these fits were epileptic, complicated with hysteria.

The various forms of epilepsy have thus been classified by Esquirol, who has seen as much of this disease as most men: essential, sympathetic, and symptomatic.

Essential idiopathic epilepsy has its seat in the brain and its appendages. It may be divided into three varieties:—

1. Idiopathic epilepsy, produced by external causes, such as forcible compression on the cranium, contusions, fractures, coup de soleil.

2. Idiopathic epilepsy, depending on defective organization of the cranium, on lesion of the meninges or of the brain, or serous or sanguineous extravasations into the cavity of the skull.

3. Idiopathic epilepsy, which may be termed nervous, produced by moral affections either of the mother, the nurse, or the patient himself: among the moral causes, anger, fright, irritation, are the most to be feared. He describes sympathetic epilepsy as presenting five varieties.

The first, he says, is connected with the digestive organs, and depends on the presence of indigestible matter in the alimentary canal—intestinal worms. I have certainly known an attack of epilepsy brought on in a patient who had been free from fits for twelve months, by indigestion consequent on a supper of cheese and radishes. Still it must not be supposed that these derangements of the stomach are the ultimate cause of epilepsy; they are merely the exciting causes acting on an irritable brain.

The second still less deserves the name of sympathetic. He designates it *angioténique*, from its seat being in the arterial system. The suppression of menses, hæmorrhoids, habitual hæmorrhages, digression from regime, abuse of liquors, provoke these.

The third has its seat in the system of white vessels, humoral epilepsy. Pale, chlorotic, rachitic, and scrofulous persons, are predisposed to it; the retrocession of porrigo, itch, ulcers, syphilis, and gout, causes this species.

The fourth has its seat in the organs of reproduction—*epilepsia genitalis*, *epilepsia uterina*, the abuse of venereal pleasures, onanism, continence, pregnancy, accouchement, are the ultimate or proximate causes.

The fifth has its seat in the external organs—*epilepsia sympathica* of authors. Every cause, apparent or hidden, which irritates some of the external parts, and of which the secondary effect radiates towards the brain, produces this variety of epilepsy.

But, with all due deference to this distinguished author, I doubt the correctness of this classification; and for these reasons—that all the causes he enumerates as productive of sympathetic epilepsy, are causes which are capable of disturbing the circulation, and that it is much more probable that this disturbance of the circulation is the cause of the epilepsy than this stalking-horse called sympathy. It is possible that our difference may be one of words merely, and that what he would call sympathetic I should call functional.

Esquirol's prognosis of epilepsy is as unfavorable as that of our own countrymen. He says—

"Sympathetic epilepsy is more easily cured than that kind which arises from constitutional causes, yet the latter is not always incurable.

"Epilepsy seldom attacks those children who have humors on the head.

"Sometimes this disease disappears for several years, and then recurs, without any assignable cause.

"Those who are attacked shortly after birth seldom recover; if they do not get well at puberty, they remain incurable.

"Those who become epileptic between the ages of three or four often are curable, if the disease be treated in time.

"Those who become epileptic a little before puberty, recover at the end of this crisis.

"Those who become epileptic after puberty, are sometimes cured, although Hippocrates thought otherwise.

"Marriage merely cures genital epilepsy; it is hurtful in the other forms of this disease. A pregnant woman who becomes epileptic is exposed to great dangers.

"When the fits occur at shorter intervals, and become more violent, death is to be feared.

"Death takes place during the prostration after the violent convulsions, not during the fit. Epilepsy, complicated with mania, is incurable."

Dr. Prichard* supports the doctrine of particular determinations of blood to distinct parts. He says we often find a patient laboring under intense and oppressive pain in the head, with vertigo, flushed and heated in the face, the pulse in the carotid and temporal arteries bounding, while the extremities are at the same time cold, the pulse small, and the vessels on the surface generally constricted. If the feet are plunged in hot water, and rubbed, blood taken from the head, and cold applied there, the pulse at the wrist and the carotid soon becomes equalized, and the headache is relieved.

Dr. Prichard believes in a power of active *dilatation* in the artery. He says, "This property of the arteries is precisely that which Dr. Parry has described under the term Tonicity." He states distinctly† that he considers "the immediate cause of an attack of epilepsy, or that physical change which, in a constitution prepared by natural predisposition, or by the action of morbid circumstances, is the immediate precursor and occasion of the fit, appears to him to be a preternatural influx of blood into the vessels of the encephalon, or an unusual fullness in some part of the vascular system of that organ." Dr. Prichard then goes very fully and ably into his reasons for this opinion.

The following case illustrates one of the forms somtimes assumed by this Protean disease. It is only by a knowledge of all its various shapes that we can understand its nature, or give a correct prognosis when consulted on the first appearance of it.

Case 85.—Nov. 6th, 1846.—I was consulted by Mrs. W., for her daughter, C. W., æt. 12, on account of the following ailment. She suddenly loses her consciousness; her hands fall, and she drops anything that may be in them; her eyes become fixed and staring; her face very red. This is followed by a sucking or convulsive motion of the lips, but not elsewhere. No cry or noise. This lasts, at the most, about three or four minutes, then she turns pale, and falls off heavily to sleep, and wakes again in about half an hour.

She first suffered in this way about two years and a half ago, and the attacks have gradually increased in frequency since: they now sometimes occur three or four times in the day. She seldom passes a day without one or two; not more liable at one period of the

* Op. cit., p. 82.

† P. 101.

day than another. She suffers very much from headache, which is especially over the forehead. She is now very nervous, and very timid, but was not so as a young child. She is intelligent, and is very clever at school. Her countenance is, on the whole, good, but the lips are a little full, and the complexion a little muddy. Her mother says, when her head aches she is always very pale. Pulse 18, 17, 19, in the quarter, very small, and a little irregular. Tongue a little dry; forehead hot; bowels regular.

Ordered—No study. Pil. Rhei co. gr. vij. Hydr. Chlorid. gr. j. M. ft. pil. ij. hâc nocte sumend. Haust. Senn. co. mane. The first dose did not operate much, but the evacuation was very dark and offensive. Repeated the dose the day after; four motions—first dark, then more natural. She has not had any kind of fit since she took the medicine.

Nov. 12th.—Ordered—Zinci Sulph. gr. ij. t. d. Pulse 22, 23.

Nov. 20th.—She had two or three fits, gr. iij. t. d.

Dec. 4.—Has had six fits since the last date, but she says that her head is much better: gr. v. t. d.

11th.—No fits since the last date; her head feels much better. Ordered gr. x.

22d.—Gr. v.

30th.—No fits; gr. v.

1847, Jan. 5th.—She reports that her daughter had one fit on the 31st of December, five on the 1st of January, two on the 2d of January—eight fits in all. They were not unusually severe; headache, but not more than usual: the last fit was the worst. Inf. Digitalis ℥ij., Dublin Pharmacopœia.

July 6th.—Has not been taking any medicine since February; she has had the attacks more frequently during the last two or three months, but they are not quite so severe; she has more warning, which she describes as a sensation in the chest. She thinks she has sometimes averted an attack by walking about. She has them now generally four or five in the day, at intervals of a week. Ordered—Argent. Oxyd. gr. j. t. d. Pulse 24.

The following case presented many points of interest. I am afraid from the severity of the attacks that there is some disease of brain. Whether this is the case or not, the disease was very much controlled by the digitalis.

It also shows the importance of giving medicines to tranquilize the stomach at the same time that we give the digitalis. For this purpose I have, on the whole, found the creosote the best; though sometimes, as in this case, I give the hydrocyanic acid.

In marking the state of the pulse in epilepsy, I always note the number of pulsations in each quarter separately, as I have frequently found much difference between the first and last quarter. (See date Nov. 21, in the following case.) When this happens I continue to count it for some little time, and note the numbers when it has settled down. The reader must therefore understand that the figures refer to the quarter, not to the whole of the minute.

Case 86.—Oct. 14, 1846.—M. T., æt. 13, tall, healthy-looking, first fit two years ago; but it is always preceded by a violent pain in the stomach about two minutes before the fit occurs. She always cries out from the pain, saying, "Oh, my stomach!" and as soon as she has said that, she goes into the fit; there is no second scream. She always turns very red in the face before the convulsion occurs. The mother says that at night she has a different kind of fit, distinguished from the day fit by its not being preceded by the pain in the stomach; but if asleep she will awake and jump up, and say, "I am going to have my night fits." She says she feels very queer for two or three days previously; never complains of singing in the ears or swimming in the head. She says she feels as if she could cry a great deal; but that she never does; she wishes she could do so. Never complains of pain in her head except *after* the fits.

Very excitable girl, very violent temper, especially before the fit. She is sometimes so bad that they do not know what to do with her. The mother calls her a very cute, clever girl; quick at anything. Her memory is now affected.

The father died from fungoid tumor in the skull; the mother alive and well.

The mother attributes the disease to the following circumstance:—About seven years ago she had an eruption (from the description I suppose eczema) on the back, which spread up to the head and formed a large wound. This was cured in about six weeks, and the girl

has never been well since. First, she could never keep anything on her stomach, always very sick; and from that came the pain in her stomach; for five years she used to cry out four or five times a-day with the pain in the stomach; but it was not followed by any fit.

She has been under Dr. Waller, and the care of a great many different persons. She was twice treated for worms, but with no good result. They then applied to Dr. L——, the water-doctor, under whose care she remained for three months. She was, after this, treated by Dr. D——; after him by Dr. A——, and was mesmerized by his orders twice a-day for about two months; and lastly, they applied to Dr. Waller, who sent her to me.

She now has the fits sometimes four or five in the day, and sometimes only once; they are generally more numerous every fortnight.

Last Tuesday night she had seventeen.

There is no difference in the night fits and the day except in the warning; she has more warning in the night.

Once she had a fit in my waiting room. I heard the cry, which was not very loud. I went into the room; she was then struggling slightly; the convulsions were truly epileptic, and principally on the left side.

Nov. 14th.—Pulse 18, 20. Inf. Digitalis (Dublin) ʒij. n. et m.

16th.—Pulse 18, 18, 17. Two bad fits, 1 P. M. and 7 P. M. ʒiv.

17th.—Pulse 23, 22, 23, ℥j. h. s.

18th.—Two fits yesterday. Pulse 18, 20. ʒx.

19th.—Three yesterday; one in the night; four in all; but not so strong. Pulse 24, 25, 23. ℥fs. n. et m. Passed a large quantity of urine.

20th.—Only one yesterday; none in the night. Pulse 23, 24. ℥j. n. et m.

21st.—None; but she has had more headache. Pulse very variable, 30, 20, 15. ℥j. n. et m.

22d.—One in the night, very slight. Pulse 25, 23. Not so much headache. ℥j. n. et m.

23d.—None in the night; two in the morning; sleepy. Pulse, ten minutes after the attack, full, 16, 16. ℥x. n. et m.; has been sick.

24th.—Has been sick again. Pulse 23, 24. ʒx. n. et m.

25th.—A little sickness; two fits since yesterday. Pulse 25, 30, 27. ʒx. n. et m.

26th.—Little sickness; very sleepy; speaks thick; looks silly. Pulse 24. Pulv. Jalap gr. v. Cal. gr. iv. Olii carui. ♏j. M. ft. Pil. ij. h. n. sum. Inf. Senn. ℥j. Magnes. Sulph. ʒj. Acid. Sulph. ♏iv. Syrup. Zingiber. ʒj. mane.

27th.—Was very ill all yesterday; but no fits.

28th.—Acid. Hydrocyani. dil. ♏iij. ex aquâ ℥j. t. d.

29th.—No fit.

30th.—Acid. Hydr. dil. ♏iv. aq. ℥j. t. d. Pulse 15, 16.

Dec. 1st.—Very queer all yesterday; a very bad fit this morning. Pulse 25, 26. Inf. Digitalis ℥j. Quin. Sulph. gr. j. t. d.

2d.—Better. Pulse 20, 21, sharp. Inf. Digitalis ℥ifs. Quin. gr. fs. t. d. Pil. Cal. co. gr. v. om. n.

3d.—Pulse 22, 20, small. Inf. Senna ℥ij. Magn. Sulph. ℥fs. Tinct. Card. co. ʒij. statim. Inf. Digitalis ℥j. Quin. Sulph. gr. fs. n. et m.

4th.—Creosote ♏j. t. d. Pulse 20, 17, intermittent.

5th.—Ditto. Pulse 23, 24, regular.

6th.—Ditto, b. d. Pulse very peculiar, stopping merely for a beat or two, and then going on. Pulse 14, 13.

7th.—Creosote ♏j. t. d. Pulse regular, 20, 21. Ext. Colocynth. co. gr. iv. om.

8th.—Pulse irregular, 16, 18.

9th.—Felt, yesterday, for some time, as if she would have a fit; but had none. Went off with crying; cried for an hour. Creosote ♏j. t. d.

10th.—Ditto. Pulse 20, 20.

11th.—Creosote ♏j. t. d. Pulse 21.

12th.—Ditto. Pulse 20, 18, 18.

13th.—Very poorly all yesterday; headache; bowels purged; no sickness; bad fits at half-past nine; interval nine days. Pulse 25.

15th.—Conf. Aromat. ʒfs. (purged). Mist. Cretæ ℥j. Spirit. Menth. Pip. ʒj. bis in die. Pulse 22.

16th.—Bowels quieter.

17th.—Rep. Mist.

18th.—Inf. Digitalis ℥j. n. et m.; fit about 5 P. M., after having a dose in the morning.

19th.—Pulse 18. Digitalis ℥ifs. n. et m.

20th.—Pulse 15. Digitalis ℥ifs. n. et m.

21st.—Pulse, first half minute 37, second 27, slightly irregular. Digitalis ℥ifs.

22d.—Fit yesterday; not ill to-day; no sickness or headache; pulse full, 18, 18; Creosote ♏j. b. d.

23d.—Quite comfortable; ditto.

24th.—Had eight in the night, very severe, two in the morning. 1 P. M. much convulsed, especially on the left side; headache. Argent. Oxyd. gr. j. t. d. The fits continued in rapid succession, but becoming weaker, until one o'clock in the day, since which they have ceased. She did not recover the use of her left hand until the evening.

29th.—Two fits in five days.

Jan. 7th.—Seven fits during the day.

10th.—Slight fits.

12th.—Pulse 20. Continue.

14th.—Two fits.

15th.—Continue Argent. Oxyd.

22d.—Has not had any fits since the last report. Rep.

23d.—One fit.

25th.—Three fits, not so severe.

26th.—Three in the day, slighter, very numerous in the night.—Continue. Did not lose the use of leg, only of the hand.

Feb. 3d.—Three, violent.

4th.—One rather slight.

15th.—Ditto.

16th.—Continue the Oxyd.

20th.—One slight fit. Continue the Oxyd.

25th.—Three slight fits.

26th.—Three fits.

27th.—Four fits.

28th.—First fit at four in the morning; continued for twelve hours, with scarcely intermission; at least two in the hour.

March 1st.—Seems pretty well again; no headache; speech slightly affected; got the use of the hand and leg sooner than usual. Rep. hirudines.

10th.—Has continued the pills.

20th.—Rep.

April 18th.—Had several fits this day; but much slighter than they had ever been before; very different.

May 5th.—None since; has been in the country—Blackheath; has continued the pills.

21st.—One bad fit.

23d.—Two fits, much lighter ones.

June 7th.—One fit.

21st.—One fit.

28th.—One fit.

July 6th.—Fits much less numerous; has applied the one leech every month to each breast, and continues the pills regularly.

Dr. Bright considers that in almost all the cases he examined,* "a state of cerebral congestion has existed as a more or less essential part of the disease, and has even been demonstrable after death." It is also interesting to me, that when he found decided morbid growths or disease within the skull, in none of all these "has the organic change extended into the medullary substance; and in most it has penetrated little deeper than the membranes themselves." So that, in fact, the disease has not extended beyond the hemispherical ganglion.

Treatment.—If there is evidence of organic disease of the brain, the prognosis must necessarily be very unfavorable, and little can be expected from treatment; but not so if the disease, as is generally the case, results from functional disturbance of the brain. Mild mercurials and counter-irritation, not carried so far as to depress the general power, should be employed when the disease appears solely dependent on cerebral disease. The next point is to ascertain whether there is any derangement in the function of any other viscus besides the brain; and if so, to employ the most efficient remedies to set it right again.

The digestive organs are generally in fault, and they ought to be first

* Reports of Medical Cases, by R. Bright, 1831, vol. ii. p. 553.

attended to. Indeed, no course of tonic medicines ought to be commenced without first giving a full dose of calomel combined with colocynth, rhubarb, or some other purgative, and the character of the fæcal evacuations examined. I never saw any good derived from blood-letting, and I have seen a *great deal of harm* from it. I bled freely in one or two cases some years ago, under the impression that the disease was inflammatory, when there was a decidedly plethoric state of the system and great congestion of the brain; but I am convinced it caused a repetition of the attacks. Even the application of leeches either before the attack, at the time, or afterwards, only does harm. Foville* is in favor of setons to the neck, and the periodical application of leeches to the arms, in plethoric individuals, with large heads, habitually injected. He also recommends the internal use of turpentine, and relates a case in point.

Epilepsy is not unfrequently caused by disease of the heart, generally hypertrophy of the left ventricle, and according to the extent of the disease may therapeutic agents be pushed; but in almost all cases hydrocyanic acid will be found of great value in subduing irritability of this organ. Local depletion in the cardiac region will also be found useful, but it must not be carried to any extent. Three or four leeches every now and then will do good, whereas twelve or twenty would excite the heart. I have also found a belladonna plaster of service, but it is in these cases that digitalis will be found so serviceable. Aconite in small doses will also be indicated.

For a knowledge of all the medicines that have been employed in the treatment of epilepsy, I must refer the reader to Dr. Copland's erudite article on this subject, from which he will learn that nearly every drug in the Pharmacopœia has been used at one time or another. I have found the sulphate of zinc, the nitrate of bismuth, the oxyde of silver, and digitalis, more or less useful. I will first speak of zinc. In the two succeeding cases its exhibition was followed by the cure of the disease. I have, however, frequently given it since, but with only temporary benefit, and some of the cases have recovered with other means; and I have treated successfully with other medicines some cases where it had been given to a great extent by other practitioners without any effect.

Case 87.—J. B., æt. 49, married man, has two children, piano-forte maker; has lived freely; but for twelve months before the attack, had abstained altogether from liquors, till within two months of the first fit—during this latter period had been in the habit of taking *sips* of brandy during the day, amounting sometimes to five or six glasses. Nothing particular in regard to the venereal passion; has always lived with his wife. He was first attacked in March, 1841, and consulted me early in May, in the same year: his own account of the case is as follows:—

"Before the first attack, I had a violent pain in the head the whole of the day, and worse towards evening; and while I was conversing with a friend, my memory failed me for some minutes before the fit, so that I could not explain what I meant. The fit lasted for about twenty minutes, was accompanied with foaming at the mouth, and violent struggling; it was a long time after the fit before I recovered my senses, and I was quite unconscious of what had occurred.

"The second attack was about six weeks after; I then had bad pain in the head for two or three hours before: but took very little notice of it. I lost my sight, and went a few paces, and fell down. I cannot say whether it was violent or not, as I was in the street at the time. I had another attack the next night, while in bed: it was not so violent as the

* Dict. de Méd. et de Chir. Prat., vol. vii., 1831.

first, but it was some time before I recovered my senses." I ordered him an aperient, and having got his secretions generally in a healthy state, I gave him the sulphate of zinc—ordering a total abstinence from stimulating liquors. The next attack, the first after I saw him, was brought on by stooping; it did not last more than ten minutes. He had another the same evening—slight. The next week he had another, but recovered sooner than before; and he had notice of their coming. Each attack was between eight and ten in the morning.

August 5th, 1842.—Has been free from attacks for at least twelve months: had an attack about 1 A. M., which, from his wife's account, was one of the ordinary character of epilepsy. He has strictly adhered to the plan of a total abstinence from liquors since I saw him; he can only account for it by the circumstance of his having been a little flurried lately, about money matters. For the last day or two he has found himself sighing very deeply, and quite unconsciously. Has felt a little dimness of vision when about his work. Ordered—Calomel gr. v. Jalap gr. vii. stat.

Sept. 8th.—Had an attack last night.

Jan. 6th, 1843.—Had another attack, which he feared was coming on, from a feeling of lowness of spirits and slight headache, but it was so slight that he paid no attention to it; he has left off the sulphate of zinc for the last six weeks—only aperients since. Ordered to renew the zinc.

March 2d.—Left off the zinc, feeling quite well; takes Pil. Rhei co. gr. v. p. r. n.

Feb. 7th, 1845.—Has returned for advice, having had a fit the night before; has been free from attacks for one year and six months, that is, from the 6th January, 1843, till August, 1844, when he was in the country. He attributed it to stooping to wash his feet: it came on in the night. He merely took some aperient medicine, and had no return till the last just mentioned; but he had severe starting of his limbs on falling off to sleep, and feels a tingling, and attributes it to wind on the stomach, as when it is expelled he is easy.

On the day previous to the occurrence of the last, he had severe headache, and cold shiverings, which he could not attribute to indigestion, as he has strictly observed my rules of diet. He had recourse to the Cal. and Jalap, with the aperient draught, which operated well, but did not avert the attack. He is free from headache, and feels well, only sore from the cramp. Pulse 76; tongue dry, but clean. Ordered Zinci Sulph. gr. ij. t. d. Pil. Rhei co. p. r. n. He took the Zinc for about six months.

June 30th, 1847.—Has abstained *in toto* from all intoxicating liquors, and continued well since the last date, not having had any fit for nearly two years and a half.

The following case illustrates an important point in regard to the advent of epilepsy, namely, that it is often preceded by frequent and very prolonged attacks of syncope. I always regard frequent fainting fits in the young of either sex as a very serious premonitory symptom of approaching epilepsy.

Case 88.—I was consulted on the 11th of November, 1837, by Mrs. W., on behalf of her son, who had been suffering for some years from epilepsy: he was a well-grown lad, 11½ years old, with a vacant look, and rather a dull complexion. From the mother I had the following particulars:—

"Memorandum of my son's illness.—He was born in India. He was not a healthy child after he had attained his second year, but never had fits, not even while teething. When two years old he lost the use of his limbs, and could not stir a joint without the most acute pain; continued in this state from March to November, when he quite recovered; the succeeding year a similar attack at the same period. During these attacks there was no eruption about him, but from the knees to the ankles there was an appearance of red and black spots, as if he had been tattooed, but this was only skin deep, there being nothing above the skin. The medical opinion was, that the blood was poor, the effect of an unhealthy clime, Assam. Since he has been in England, no similar attack has taken place. His stomach was always large, till two years ago, when his sides were much blistered and leeched, and he was treated for a diseased liver. About eight months ago he complained of frequent attacks of pain in his head, as if he had a weight there. The pain in his head was succeeded by giddiness, for which his temples were leeched, and, bleeding profusely, he fainted at the time, and again the next morning; he continued daily to faint, sometimes from six to eight times in an hour; never struggled or changed color in these fainting fits; always came to with cold water or salts. Previous to fainting, he complained of pain extending from the lower part of his stomach to the chest. He now began to have a horror of water, or of smelling anything during the faints. From April to July he had on an average never less than eight fits in the day, and sometimes as many as twenty. In July the fits began to change in character, still occurring daily: sometimes he was much convulsed, and at other

times groaned; he would sing, dance, and talk of things he would not do when in a right state of mind. During these fits, though with his eyes shut, he knew the footstep of every one that entered the room; knowing any one by the feel of their hands, walking, dressing himself, picking out his clothes from those of his brothers by the feel, with his eyes quite shut; he was exceedingly violent if opposed."

The intellect was a good deal weakened when he first came to me for advice, and his mother feared he was becoming idiotic.

The medical treatment was very simple. At first I attended to the digestive organs, and after awhile I gave him the sulphate of zinc in doses of two grains. This he continued for about three months, and ultimately quite recovered, and is now serving with the army in India.

The medicines that I have found most beneficial are the oxyde of silver and the infusion of digitalis. In two cases, already related, the infusion of digitalis succeeded after the oxyde of silver and bismuth had been tried, and failed. But as far as I have yet seen, the infusion of digitalis is adapted to young and excitable subjects, the silver to older patients, where the disease is more confirmed and the fits do not occur so frequently. For a knowledge of the value of the oxyde of silver in these cases, and the best mode of using it, I am indebted to my late and lamented friend Dr James Johnson. For the digitalis I am indebted to Dr. Corrigan, whose observations were copied in the Medical Gazette* from the Dublin Hospital Gazette. Dr. C. states that the digitalis has long been a quack remedy for epilepsy in Ireland, but that it was used in such tremendous doses that frequently its effects were terrific.

It occurred to Dr. Corrigan that if he could succeed in saturating, as it were, the nervous system with its sedative influence without the risk of inducing those frightful effects which follow on the exhibition of a large dose, he would gain an important point in practical medicine. After many trials of its preparations he gives the preference to the infus. digitalis of the Dublin Pharmacopœia, but he cannot too strongly insist on the greatest attention being paid to see that the leaves are well prepared and of the latest gathering. The mode of the administration is to begin with ʒj. of the infusion every night at bedtime, increasing it after a week to ℥iss., and after another week to ℥ij., beyond which it is rarely necessary to go, and continuing it till sickness of the stomach and dilated pupils are observed, when the dose is to be diminished by ℥ss. or ℥j., till the maximum dose that can be borne without inconvenience be ascertained, which quantity is to be taken for two or three months. Given in this way its administration is attended with no inconvenience beyond an occasional attack of slight sickness of stomach in the morning, or headache, &c., when the medicine is to be discontinued, and a day or two are to be allowed to pass over before resuming its use. With the exception of these symptoms there is no perceptible effect, except slow action of the heart, and the patient is able to continue his ordinary avocations.

In the use of digitalis as a sedative to the heart's action, I have never found it act as a diuretic; and this I account for by not having combined it with other diuretics, as the neutral salts, or the bichloride of mercury, &c. I have not spoken of the state or quantity of urine, as I soon found it was uninfluenced by it. Dr. Munk† has made some excellent obser-

* Vol. 36, p. 1473.

† Dr. Munk on the Action of Digitalis, p. 295, Guy's Hospital Reports, for October 1844.

vations on this subject, which I have not room to quote here so fully as I should wish, but I must extract those which conclude his paper. "A remedy, it has been well observed, can scarcely serve and hurt the constitution at the same time; and digitalis, where it gradually and in a kindly manner abates the heart's action, or stimulates the kidneys, never, according to my experience, accumulates, or produces, in a prominent degree, those alarming symptoms, upon which writers have so amply dilated."

The best account of the use of digitalis as a medicine, historically and therapeutically, will be found in a treatise by Dr. William Hamilton, of Bury St. Edmund's, 1807. It is well worthy of perusal. Many cases of epilepsy are complicated with menorrhagia, and in these cases I found the digitalis additionally useful. Dr. Ferriar, who has published an essay on this subject, states that he prescribed it with great benefit in hæmorrhage generally, but especially in menorrhagia.

In relating a few more of the cases in which I have found the digitalis beneficial, I shall again advert to its use when there is any disturbance of the uterine functions, and the propriety of combining it with other medicines. When I give the digitalis I always keep, or have kept for me, at the commencement, a daily account of the pulse, numbering the pulsations in the quarter, as related in the next case; after I have employed it for some months, I am then satisfied with a report every other day.

Case 89.—November 7th, 1846.—A. B. C., æt. 16, a tall, delicate-looking girl, with a pleasing countenance, has had fits since she was seven years old. The first followed scarlatina, with an interval of two or three months. She had none of the usual sequelæ of the disease. Father and mother died of phthisis. She was in strong convulsions for a short time, and then insensible for above four hours. She first menstruated at 13, but not regularly—three and five weeks. She generally has the attacks every month in bed, three at a time. In the day she has often a warning of an attack, so as to cry out, "My nose." Her grandmother has found that by pinching the nose she has averted the attack. The fits are not ushered in with a decided cry. She recovers her senses in about ten minutes, and then falls off to sleep. She says that the sensation it comes on with is a *trembling* in her bowels. She cannot describe it in any other way. No headache before the fits, but always after, which is removed by sleep. Bowels regular; intellect has been very good, but is now beginning to fail. She had ascarides five or six years ago, but none lately.

Last attack, three or four days ago, three fits; two days after, one more; two days after, one;—five in all. Pulse 23, 21, 22, in the quarters. Ordered, Inf. Digitalis (Dublin Pharmacopœia) ℨij. hâc nocte.

7th.—This night she took the medicine, and had three fits, and vomited violently.

8th.—She had the commencement of an attack, but it appeared to be averted by pinching the nose and pouring some sal volatile into her mouth. Inf. Dig. ℨij. h. n.

9th.—Pulse 29, quarter of minute; ℥ss.

10th.—Pulse 20; ℨvj.

11th.—Pulse 20; ℥j.

12th.—Pulse 20, 18, 18; ℨx.

13th.—Pulse 19.

14th.—Has had several threatenings, but no complete attack; pulse 22, 19, 19, 19; ℨx.

15th.—Pulse 19; ℥j.

16th.—Pulse 18; ℨx.

17th.—Pulse 21, 21, 21; ℥iss. Has not had any complete fit since the 7th, but severe threatening; she also complains of such horrid thoughts of cutting throats, and jumping out of windows. She is now menstruating, and has been so this week; it is now always very profuse.

18th.—Pulse 19; ℥iss.

19th.—Pulse 20; ℨiv.

20th.—Pulse 16; ℥ij.

21st.—Pulse 16, 16; no complete attack, but several tremblings; hiccup and sickness.

Continue Pil. Rhei co. gr. viij. hâc nocte. Cal. gr. ij. Inf. Senna ℥j. Syrup. Zingib. ʒj. Magn. Sulph. ʒij. Acid Sulph. dil. ♏iv. mane.

22d.—Pulse 16, 17, 18, 17.

23d.—The aperient has acted very freely; the pulse is sharp and full—20, 18; ʒx.

24th.—Pulse 20; ʒxij.

25th.—Pulse 18; ʒxiv.

26th.—Pulse 18, 17, 18; vomited this morning; ʒvj. Pil. Rhei. co. gr. vj. Cal. gr. j. Inf. Senn. ℥j. Magn. Sulph. ʒj. Acid Sulph. dil. ♏v. Syrup. Zingib. ʒj. mane; to be taken to-night, if the sickness continues.

27th.—Pulse 17; Pil. et H. ut supra hâc nocte.

28th.—Pulse 20; two fits.

29th.—Pulse 20; one fit; Rep. Haust. Digit. ℥vj.

30th.—Pulse 19, 16, 18; Inf. Digit. ℥j. Pil. Rhei co. gr. v. p. r. n.

December 1st.—Pulse 20; no attack; ℥j. ʒij.

2d.—Pulse 18, 17, 18, 18; one nervous attack; ʒx.

3d.—Pulse 16, 18, 18, 18; none; ʒx.

4th.—Pulse 20; three slight; ʒxij.

5th.—Pulse 18, 20; several; ʒxij.

6th.—Pulse 18, 20; four slight; ʒxij.

7th.—Pulse 20, 18, 20, 20; three slight attacks; ʒxij.

8th.—Pulse 18, 20, 18; ℥ij.

9th.—Pulse 18; Pil. Rhei gr. v. h. n.

10th—Pulse 18; one or two slight attacks; Rep. H. Digit. ℥ij.

11th.—Pulse 19, 19, 19; ℥ij.

12th.—Pulse 20; ʒxiv.

13th.—Pulse 20; ʒxiv.

14th to 17th.—Repeated nervous attacks, but slight; ʒxiv.

18th.—The same; Hyd. Chlor. gr. iij. h. n. Haust. Aper. mane.

20th.—Pulse 19, 20; omit the Digitalis.

21st.—Pulse 20, 19; Rep. Hs. Digit. ʒxiv. The nervous affections frequent, and excessively low in the animal spirits.

22d.—Pulse 18, 19; two more complete fits; Creosote ♏j. Panis. q. s. ut fiat Pil. j. ter in die.

23d.—Pulse the same as day previous.

24th—The same. On this occasion she was not ill as usual, previous to the menstrual period, but the fits came after; they were not so severe as usual, for she did not even know of their occurrence. The menstrual discharge was not so profuse as usual. The nights have been better since taking the Creosote.

26th.—Pulse 18, 18, 19, 19; Creosote ♏j. t. d.

28th.—Pulse 18; Rep. Pil.

30th.—Pulse 18, 17; two nervous; Rep. Pil. Creosote

31st.—Pulse 18, 19; Rep. Pil.

January 2d, 1847.—Pulse 18, 17; Rep. Pil.

4th.—Pulse 18, 18; Rep. Pil. Creosote.

5th.—Pulse 20; Rep.

6th.—Pulse 20, 20.

9th.—Pulse 20, 20; Pil. Creosote; b. d.; Inf. Digitalis; ℥ss. nocte.

11th.—Pulse 20, 20; Rep. H.; ℥j.

13th.—Pulse 20; Rep. H.; ℥iss. nocte.

14th.—Pulse 18, 16; half attacks less frequent and less severe than they were; ℥iss.

16th.—Pulse 18; Rep. Digit.

18th.—One slight.

19th.—Pulse 20, 20; slight attacks, not as it used to be: Rep. Digit. ℥ij.

20th.—Pulse 18, 18, 18; ℥ij.

22d.—Pulse 18; ℥ij.

24th.—Pulse 18, 18; ℥ij.

26th—Pulse 18, 16, 17; ℥ij. Pil. Rhei co. gr. v. h. n. Nervous attacks less frequent, some days none; less severe.

28th.—Pulse 19, 18.

30th.—Pulse 17, 16; Rep. Digit.

February 1st.—Pulse 17, 16.

2d.—Pulse 17, 16; Rep. ℥ij.

4th.—Pulse 17, 16; Rep. ℥ij.

6th.—Pulse 16, 16, 17; Rep. ℥ij.

8th.—Pulse 18, 20.

10th.—Pulse 18, 20; ℥ij.

12th.—Pulse 19, 20; nervous attacks frequent in the last day or two; this is the case after aperient medicine.

13th.—Pulse 18, 19, 18; ℥ij.; Creosote ♏j. b. d.

14th.—Whole attack in the morning, after rising, but not so long or so severe.

15th.—Another about 7, after rising; pulse, 11 A. M., 20, 21, 20; Inf. Digitalis, ℥iss. nocte, ditto, ℥ss. mane; omit Creosote; Hirud. ij.; singulæ mammæ.

16th.—Menses returned; slept well.

17th.—Pulse 18, 18, 18; one fit.

18th.—Another fit, stronger.

19th.—Pulse 36, 18; Inf. Digitalis ℥ij. Spirit Menth. Pip. ʒj. o. n. Creosote ♏j. Ext. Rhei gr. iij. Misce fiat pil. j. bis in die sumenda.

22d.—Pulse 18, 18.

23d.—Pulse 18, 18; ℥j. o. n. Rep. Creosote b. d.

25th.—Pulse 18, 18.

26th.—Pulse 16, 17, 18; ℥ss. o. n.

28th.—Pulse, 17, 18.

March 1st.—Pulse 17, 17, 16.

2d.—Pulse 18, 18; ℥ij.

4th.—Pulse 16, 16.

6th.—Pulse 17, 16, 18; ℥ij.

7th.—℥iss. alt. nocte.

8th.—Pulse 16, 17, 17; ℥ij.

9th.—Pulse 16, 17, 16; ℥iss. o. n.

10th.—Pulse 17, 17, 17.

12th.—Pulse 17, 17; Rep. H. Digit. ℥iss.

13th.—Pulse 16, 16, 17; ℥ij. o. n.

14th.—Fit, 5 A. M., slight; about the monthly period, but the menses have not appeared.

15th.—Pulse 17, 17, 17.

16th.—Pulse 18, 17; ʒiss. o. n.

18th.—Pulse 20, 20; ℥iss.

19th.—Pulse 17, 17, 17; ℥iss.

20th.—Pulse 17, 17, 17; ℥iss.

22d.—Pulse 17, 16, 17; ℥iss.

23d.—Pulse 16, 16; ℥iss.

25th.—Pulse 15, 16, 16.

26th.—Pulse 17, 17, 17, 17; one fit; ℥iss.

27th.—Pulse 22, 23, 23, 23; two fits this night; ℥iss.

28th.—Pulse 16, 17, 16; one fit in the night, with sickness;—four fits in all; no Digitalis to-night: the vomiting is so severe, that Mrs. —— was afraid to give her the Digitalis. She took the Creosote twice in the day. The bowels having been confined, she has generally had the Pil. Rhei co. gr. v. every other night; the last fit very slight.

29th.—Pulse 17, 17, 17, 18; no Digitalis last night; Inf. Digitalis, ℥iss. o. n. Creosote ♏j. b. d. Pil. Rhei co. gr. v. p. r. n.

31st.—Pulse 15, 16, 16, 15; Rep. H. Digit.

April 1st.—Pulse 16, 16; Rep. Digit.

3d.—Pulse 16, 17, 16, 16.

4th.—Some threatening of an attack.

5th.—Pulse 16, 17, 17; Rep. Creosote. Rep. Digital. ℥ij.

6th.—Pulse 16, 16; Rep. Digit. ℥ij.

8th.—Pulse 17, 16, 18, 18; Rep. Creosote. Rep. Digit. ℥ij.

10th.—Pulse 18, 20, 20, 18.

11th.—Pulse 15, 16, 16; Rep. Digit. ℥ij.

12th.—Pulse 16, 17.

14th.—Pulse 17, 16, 17.

15th.—Pulse 16, 17; Rep. Dig. ℥ij.

16th.—Pulse 20, 19; Rep. Dig. ℥ij.

18th.—Pulse 16; Rep. Dig. ℥ij.

19th.—Pulse 20, 20; after dinner and exercise.

20th.—Pulse 16, 15; ℥ij.

22d.—Pulse 20, 20; after trundling her hoop; ℥ij.

23d.—Pulse 18, 18; ℥ij.

24th.—Pulse 19, 20.

25th.—Pulse 18, 19.

27th.—Pulse 16, 16, 18; Ferri Sulph. gr. j. Creos. ♏j. Aloes co. gr. v. o. n. She men-

struated this morning. On Saturday evening, that is, the 24th, she had a very slight fit, slighter than they have known them before. Ord.—Ferri Sulph. gr. j. Creosote ♏j. b. d. Inf. Dig. ℥ij. o. n. Pil. Aloes co. gr. v. o. n.

28th.—Pulse 16, 16, 18; ℥ij. o. n. Creosote ♏j. Ferri Sulph. gr. j. Quinin. Sulph. gr. j. bis in die. Pil. Aloes co. gr. v. o. n.

29th.—Pulse 17, 17; ℥ij. o. n.

30th.—Pulse 17, 18.

May 2d.—Pulse 17, 16, 16; Rep. H. Digit.

3d.—Pulse 17, 16; Rep. Dig.

4th.—Pulse 16, 16.

5th.—Pulse 15, 16, 15; Rep. Dig.; has passed the monthly period without any attack, the first time this has occurred.

7th.—Pulse 14, 15, 15.

9th.—Pulse 15, 16.

10th.—Pulse 16, 14; Rep. Omnia.

12th.—Pulse 18, 18, 17.

14th.—Pulse 16, 17; Rep. Inf. Dig. Ferri Sulphatis gr. j. Pil. Aloes c. Myrrh gr. ij. b. d. Pil. Cal. co. gr. v. o. n.

15th.—Pulse 17, 18; Rep. Digit.

16th.—Pulse 16, 17.

17th.—Pulse 16, 17.

18th.—Slight fit this morning; sickness and vomiting afterwards; bowels freely opened. Ord.—Pil. Col. h. n. Inf. Dig. ℥j. h. n. Omit Pil. Ferri.

19th.—Pulse 20, 20. Rep. Inf. Dig. ℥j.

20th.—Pulse 18, 18. Rep. Ferri. Inf. Dig. ℥iss.

22d.—Pulse 17, 18.

24th.—Pulse 16, 16. Rep. Omnia.

25th.—Pulse 19, 20, 19. ℥ij.

26th.—Pulse 17, 18, 17, at noon.

27th.—Pulse 17, 17, 11 A. M. ℥ij. Omit Ferri.

28th.—Pulse 17, 16, 17, at noon; in the evening, 17, 18, 17.

29th.—Pulse 17, 17, 18, 18, vespere. Inf. ℥ij.

30th.—Pulse 17, 17, 17, ditto. Rep. Dig. ℥ij.

31st.—Pulse 16, 18. Rep. Dig. ℥ij.

June 1st.—Pulse 17, 18, 17, late in the evening, after a long walk.

3d.—Pulse 15, 15, 11 A. M. Rep. Ferri. Inf. ℥ij.

6th.—Pulse 16, 16, in the evening.

7th.—Pulse 16, 16, 16, 16, vespere.

8th.—Pulse 14, 15, 15. Rep. Ferri. Inf. Digitalis ℥ij.

9th.—Pulse 17, 16, o. n.

10th.—Pulse 17, 16, 17. Rep. Digit. ℥ij.

11th.—Very slight fit, six weeks interval. Pulse 18, 17, 18. ℥ij. Continue Ferri quotidie.

12th.—Pulse 17, 17, 17, 17.

14th.—Pulse 16, 16, 16. Rep. Inf. Digit. ℥ij.

15th.—Pulse 17, 16, 17. Rep.

17th.—Pulse 21, 21, vespere.

18th.—Pulse 18, 18, 18, mane, Rep. Omnia.

19th.—Pulse 17, 17, 17.

21st.—Pulse 17, 17, 17, in the morning, after a walk of three miles.

22d.—Pulse 15, 16, 16. Rep. Omnia.

24th.—Pulse 16, 17, 17.

25th.—Pulse 14, 15, 14. Ferri Sulph. gr. ij. b. d.

27th.—Pulse 19, 20, 19. ℥iss. h. n.

28th.—Pulse 15, 15, 15. Ferri in die Inf. ℥iss. o. n.

30th.—Pulse 16, 15, 16. Rep. Digit.

July 2d.—Pulse 16, 17. Ferri Sulph. gr. ij. in die. Inf. Digit. ℥iss. o. n. Feels quite well; very few nervous feelings now.

I have already stated that I have not found the Digitalis so successful in old standing cases of epilepsy in the adult as in the younger subject; but I have always found it exert a very decided controlling power over the disease. This was very strikingly exhibited in the following case, which is also interesting, as showing that its long-continued use is sometimes attended with injurious effects. The case receives an additional

interest from the clear way in which it is detailed by Mr. Greenhow, of Tynemouth, by whose advice I was consulted. Its connection with a cutaneous eruption is important.

Case 90.—Mr. S. T. P., æt. 21, was, during infancy and boyhood, the subject of a chronic cutaneous affection, extending over the hands, arms, and lower part of the face, and which only finally disappeared within eighteen months or two years of his first epileptic seizure. After the cessation of the eruption he became enormously fat for his period of life, and acquired a pale, pasty kind of complexion. He has at no time manifested any symptom of aberration of mind or deficiency of intellect, and is at the present period (Oct. 1845), in much better general health than at the period when I was first consulted. He is also much less corpulent, and has lost, in a great measure, the peculiar character of the countenance before described.

Mr. S. T. P. has always been prone to derangements of the stomach, accompanied by great tendency to sickness, which he has been accustomed to encourage by copious draughts of warm water; and by occasional headache and feverishness. His tongue, always more or less furred, has a swollen, sodden kind of appearance, and is also deeply indented by the teeth. The pulse is regular, rather small, and averages 70.

His father took a prominent part in the election of 1841, and he, being one of his father's clerks, was exposed to great mental as well as physical excitement. At 5 A. M., July 23, 1841, (at that time being 17 years of age,) he was awakened out of his sleep by a sensation of cramp in the left leg, which was immediately followed by an epileptic fit. I did not see him during the attack, which lasted a very short time, but found his stomach much deranged on the following day. At first the attacks succeeded one another at regular intervals; generally between the hours of 4 and 5 A. M., and were always preceded by the *aura epileptica*, which awoke him and gave time to alarm his father and mother, who slept in the adjoining room. If at any time he had a slighter paroxysm, it was most frequently succeeded by a second on the following morning. The fits have generally been followed by sleep; but there has hitherto been no tendency to coma, and whenever headache or feverishness have occurred on the following day, they have clearly been referable to disorder of the digestive organs. There has from the first been no biliary derangement, and the action of the bowels is regular and efficient without the aid of medicine.

During the last two years I have been only very occasionally called to see him; but the epileptic attacks still occur, though less regularly and with longer intervals. Various modes of treatment having been diligently tried without any very decided benefit, medicine has of late only been had recourse to when the attack has been succeeded by feverishness or unusual derangement of the stomach. He has, however, within about a year had three or at most four attacks in the day-time, and in the waking state. On the occurrence of the first of these day seizures I was sent for, and found him just recovering, although unable to speak. It was only after free vomiting, and the lapse of half an hour, that he recovered his speech, or could walk steadily. On that occasion he attributed the paroxysm to a fright; but the other day-attacks have been preceded by no apparent cause.

Taking the history of the case into consideration, I, in the first instance, directed my attention to removing the evident derangement of stomach, which complicated if it was not the indirect cause of the epilepsy. All excitement was strictly forbidden, and a very restricted diet, with abstinence from stimulants, was prescribed. Small doses of Pil. Hydrarg. with stomachic tonics were administered, and his bowels were kept free by the use of mild laxatives. Exercise in the open air was enjoined; and he, for many months, entirely gave up attendance to business. An issue was also made in his arm, from which a free discharge was kept up for many consecutive months. After he had had three or four attacks he was seen with me in consultation by Drs. Greenhow, of North Shields, and White, of Newcastle; and, at their suggestion, the Pil. Hydrarg. was continued until the gums became tender. Afterwards, at Dr. White's suggestion, he took the following:—℞. Pulv. Rad. Dictamni. Exotic ℥iss. Pulv. Rad. Zedoar. Flav. gr. xv. m. in ch. v. divid. cap. j. primo mane quotidie ex aquâ. He was, at the same time, restricted to vegetable and farinaceous food; all kinds of meat, animal broths, stimulants, tea and coffee, being prohibited. The bowels were kept free by daily doses of castor oil, and a free eruption was kept up on the arms for several weeks by the use of the following liniment—℞. Ol. Croton ʒj. Sp. Terebinthinæ ℥vj. T. Lavend. co. ʒj. m. ft. Liniment.

The powders were increased in strength from time to time; but after persevering in their use, without any decided benefit for seven months, they were finally abandoned. He has also tried the Nit. Argenti twice for about four months, with a few weeks' interval between the two courses; likewise the Liq. Potassio. Arsenic. All these plans of treatment having failed, he has long ceased to employ internal remedies systematically, although attention to diet and regimen has been frequently and stringently enforced.

On the receipt of this report I wrote to Mr. Greenhow to the following effect:

"Oct. 15th, 1845.—I believe that epilepsy is generally dependent on disturbance of the organs of digestion and generation when it is not occasioned by positive disease of the nervous system. I have no doubt that Mr. S. T. P.'s attacks are referable to such disturbance, and not to any organic disease of the brain and spinal cord; and if this view is correct we may possibly effect a cure, though it would not be right to hold out any certain prospect of such a desirable result after so much has been tried in the way of medicines; but I never despair now, after the recovery of a friend who had the disease for fifteen years, beginning at about the age of twenty.

"I could, indeed, mention five or six cases of adults who have recovered under similar treatment. The general plan I will now explain, with the understanding that it is only to be carried out under your own supervision. Medicine is certainly of great service in this disease, but diet, &c., are even more important, or rather, I should say, that the one is valueless without the other.

"First, with regard to diet:—

"*Breakfast.*—Plain dry toast or home-made bread, without butter; milk and water if milk agrees, if not, *weak* tea or cocoa.

"*Luncheon*, about one.—A small sandwich and a biscuit, with a tablespoonful of brandy in half a tumbler of cold water, without sugar.

"*Dinner*, not later than five.—Plain roast, boiled, or broiled mutton; no other meat. Mealy potato. Farinaceous puddings, but no pastry, no fruit, no preserves, no dessert of any kind; the same quantity of brandy and water; no wine or beer.

"*Tea* should not be a real *meal*, only a little very weak tea, and toast without butter.

"Cold shower-bath the first thing after getting out of bed, warm water for the feet. If unaccustomed to the shower-bath, to be used tepid for the first few days. A short run or walk before breakfast. As much walking exercise in the day as can be taken without fatigue; no horse exercise; no mental excitement; no sexual excitement; to sleep on a matress, the feet well covered. If the feet are cold on going to bed, to put them in warm water. The medicines I have prescribed on another sheet. In all the cases in which this plan has succeeded, it has not succeeded immediately, but the attacks have gradually lessened in force and frequency.

"Sincerely hoping that we shall meet with success, I will now subscribe myself, yours very sincerely, "S. S."

"Argent. Oxyd. gr. j. Ext. Cal. co. gr. ij. t. d. Liq. Potass. Brandith. ℥iss. Tinct. Iodin. co. ʒj. Spirit Æth. Nit. ℥iss. sumat cochl. min. ex cyatho vinoso aqua bis in die sumat."

"Tynemouth, 21st November, 1845.

"My Dear Sir—I have intended writing to you for some time past, having in the first instance deferred doing so until I was satisfied the plan you suggested was agreeing with my patient . . .

"Mr. S. T. P., I am glad to say, appears to be going on well. A few days previously to commencing the medicine he had a threatening without the succeeding fit, which he entirely escaped, and he has had two slight fits since. I have made him discontinue the sandwich for luncheon, and substitute plain bread or biscuit, as he has become fatter since he followed your plan; in other respects he pursues it strictly."

"Tynemouth, 25th February, 1846.

"My Dear Sir—I almost fear you must have thought me inattentive in allowing so long a period to elapse without again giving you a report of our patient's progress. I have not, however, thought it necessary to trouble you sooner, as no material change has taken place since my last, and you had led me to expect the improvement would be very slow. He has now pursued the plan for four months, and although the number of attacks, during that time as compared with the same period in the four preceding years, has been greater,—this year there have been seven seizures between the 17th of November and the present date, and previously they have never exceeded five.—I think his general health improved by the treatment you suggested; and his father is decidedly of opinion that the attacks are shorter in duration and less violent than they used to be. Under these circumstances, I am disposed, provided you agree with me in the opinion, to pursue the plan for some time longer. That you may be better able to judge of his state as to the frequency of attacks under the different plans of treatment he has pursued, I inclose a comparative statement of his case on these points during the same period in each year since he was first seized. I ought also to mention that his tongue is improved in character, and that his skin has assumed a more healthy appearance. He dined with some friends on the 26th of November, and evidently disordered his stomach. To this I attribute the attacks on Nov. 27th, Nov. 30th, and Dec. 2d; at this time he had a good deal of sickness; headache, and lassitude, with depression of spirits and feverishness. Have you seen a plan, recommended I believe originally by Dr. Corrigan, for

treating epilepsy with Digitalis? I remember to have seen a short account of it in one of the Journals, but too brief to enable me to judge of its merits.

"Believe me, my dear Sir, yours very sincerely,

"E. Headlam Greenhow."

In answer to this I wrote to advise the omission of the oxyde, as I was afraid of discoloration of the skin, as he had taken it four months, and I recommended the use of the Digitalis as prescribed by Dr. Corrigan, having now had a good deal of experience of its efficacy.

"Tynemouth Place, 10th Sept. 1846.

"My Dear Sir—I have not thought it necessary to trouble you earlier with any statement of the progress of Mr. S. T. P.'s case. I have kept tolerably minute notes of his state since I last wrote to you, and proceed to give you a brief abstract of them. The last attack of epilepsy before commencing Dr. Corrigan's plan, was on the 14th of February. On the 26th he commenced taking the Digitalis, on which day his pulse was 64; ten days afterwards (March 7th) the pulse had risen to 80. He had attacks on the 7th, 17th, and 28th of March. That on the 28th was so slight that he did not become entirely insensible, although he had the *aura*, convulsions, and loss of speech. The dose was gradually increased, until on the 31st of March he took 2½ ounces of the infusion, prepared according to the Dublin formula (equal to 5 oz. Pharm. Lond.). On April 1st, he was very sick; pulse 60, weak and irregular; headache, pains in the limbs, and along the course of the spine. The Digitalis was now omitted for three nights, when his pulse having resumed its natural character, he recommenced with the original ½ oz. doses. In four days his pulse fell to 50. On the 8th day (April 12th), having taken 1½ oz. the evening before, he complained of pain in the shoulders, chest, arms, back and limbs. April 13th.—Sickness; pains much increased; slight headache; pulse 90, small and feeble, but regular. From this time the Digitalis ceased to affect the regularity of the pulse, which, contrary to its former and more usual effect was henceforward uniformly increased in frequency as the patient came under its influence. The draught was omitted on the 13th of April, but resumed on the 14th. On the 16th the pain had increased; there was also tenderness, generally, over the abdomen, more intense at the epigastrium; tongue coated, with redness of the tip; rapid emaciation. On the 17th he was covered with an eruption, closely resembling measles, which extended over the back, shoulders, chest, abdomen, arms, limbs, and face. No urtication. On the 18th the redness had disappeared from the tongue, but the tenderness at the epigastrium continuing, eighteen leeches were applied. On the 20th, the tongue had the tremulous character observed in delirium tremens; and on the 22d his hands were also tremulous. On the 25th of April he had a threatening, which, after walking two or three times across the floor, passed off, without a regular attack. This is the first time he ever had the *aura*, and other feelings of an impending fit, without their being succeeded by one. He continued the Digitalis for the most part regularly, during this period, only omitting it once or twice for a single night, when the symptoms were most urgent. The dose, at this time, averaged 1½ oz. (equal to 3 oz. P. Lond.), but varied according to circumstances. The eruption continued with but slight alteration for many weeks, only acquiring a bluish leaden kind of tinge, and being accompanied by slight desquamation of the cuticle. On the 16th of May it was again necessary to apply leeches to the epigastrium. The Digitalis was continued until the 20th of June, when his general health having become much impaired, I began to reduce the dose. He had not, however, entirely discontinued it, when, on the 28th, he had an epileptic seizure, but much slighter than usual. I again caused him to resume the full doses of Digitalis, and he continued them until the month of August, when he had another attack. For some weeks he had complained much of pains in the joints, which always diminished when the dose of Digitalis was lessened for a day or two, and *vice versâ;* but about the middle of August these gave place to an attack of ophthalmia, accompanied by pain in the facial nerve, and above the eye, as well as very acute pain in the eyeball. Simple treatment failing, I was obliged to get him gently under the influence of mercury, since which it has entirely disappeared. He has lost flesh greatly since commencing this plan, and his general health is so much impaired, that, taken into consideration together with some slight pectoral symptoms, which have shown themselves during the last few weeks. I have advised his father to abandon all treatment, at present, for the cure of the epilepsy. I think you will fully agree with me, when you consider the great variety of treatment that has been unavailingly tried during so long a period; and that the only remedy (the Digitalis) which has really appeared to control the attacks, has produced so much disorder of the general health. In another case in which I have tried the same remedy (a female), the attacks have been less frequent, but have nevertheless returned at regular intervals. I am satisfied that Digitalis occasionally exercises a very decided influence over the complaint, and I think that it may prove successful in a few instances; but my experience leads me to think its administration requires great caution, and I should scarcely again persist

so long in its use as I have done in Mr. S. T. P.'s case. Begging you to execuse all defects, as I write in haste,

"Believe me, my dear Sir, very sincerely yours,

"E. Headlam Greenhow."

List of Mr. S. T. P.'s attacks of epilepsy, between the 16th of November and 12th of February in each year, since 1841:—

1841, November 16th.—Two slight attacks; first at $2\frac{1}{2}$ A. M. and second at 7 A. M.; was each time awoke out of his sleep by the *aura.*

23d.—One attack at 7 A. M.; was awoke by the *aura.*

29th.—Was awoke at 7 A. M. by the *aura*, followed by slight convulsion, without becoming insensible.

Dec. 13th.—An attack at $6\frac{1}{2}$ A. M.; was again awoke.

1842, Jan. 1st.—An attack at 5 A. M.; ditto.

Feb. 26th.—Two attacks whilst asleep, each time being awoke, as usual, by the *aura;* the first at half-past 4, and the second at half-past 7 A. M.; likewise a third, in the waking condition at 6 P. M. These were all slight attacks, and the last was the first he ever had whilst awake.

Until the 21st of November 1841, the treatment consisted of bitter tonics, and alterative doses of blue pill, with strict regimen, and the cold shower-bath, and during the remainder of the period comprised in the table, of half-grain doses of Arg. Nit. three times a day.

Had no attack between September the 28th and November the 29th. The Arg. Nit. was continued until the 20th of April, and from that period he took Pulv. Dictamni Exotic, and Pulv. Zedoar, as mentioned in my former report.

Nov. 29th.—Two attacks, first at 5 A. M. the second at 6 A. M.—slight.

Dec. 19th.—Was awoke at 5 A. M. by the *aura*, followed by slight convulsion, but without insensibility.

1843, Jan. 5th.—A similar threatening to the last, at 5 A. M.

17th.—Ditto, ditto.

Feb. 11th.—An attack at 6 A. M.

23d.—Ditto, ditto, at 7 A. M.

The Pulv. Dictamni, &c., were continued until the 20th of December 1842, and then abandoned. An issue was kept open in the arm for some months from August 1842, and his diet was restricted to vegetables and farinaceæ, from April until the commencement of 1843. All stimulants had been prohibited from the first.

Nov. 11th.—An attack at 3 A. M.

Dec. 2d.—Ditto, ditto, 7 A. M.

22d.—Ditto, ditto, 4 A. M. Likewise a threatening, such as before described at 7 A. M.

1844, Jan. 15th.—An attack at 2 A. M.

Feb. 26th.—Ditto, 7 A. M.

The issue was allowed to heal up in April or May, and I discontinued regular attendance upon him, although I always heard of his attacks. Three or four times during the year 1844 I was called in when the seizures were unusually severe, or when his digestive organs were deranged, but tried nothing on these occasions, beyond a little alterative aperient—Pil. Hyd. Pil. Rhei. co. Ext. Hyoscyami—and occasionally Infus. Gentian or Calumbæ, with Carb. Sodæ, for two or three days at a time.

1844, Nov. 9th.—An attack at 7 A. M.

20th.—Ditto, ditto, at 7 A. M.

Dec. 17th.—Ditto, ditto, at 5 A. M.

1845, Jan. 20th.—Ditto, ditto, at 5 A. M.

Feb. 8th.—Ditto, ditto, at 3 A. M.

I was only once consulted by him between August 1844 and November 1845. During the whole of this period, nothing was done, and I do not think he was particular in diet, or in any other respect.

1845, Nov. 10th.—An attack out of doors, at 9 A. M.

27th.—An attack at 10 A. M.

30th.—Ditto at 12 P. M.

Dec. 2d.—Ditto, at 4 A. M.

9th.—Ditto, at 4 A. M.

1846, Jan. 3d.—Ditto, at 3 A. M.

Feb. 2d.—Ditto, at 6 A. M.

14th.—Ditto, at 7 A. M.

During this period he has been pursuing the treatment recommended by Mr. Solly.

"Tynemouth, 1st July 1847.

"My Dear Sir—I think I mentioned that Mr. S. T. P. had an attack of ophthalmia. He

has had several subsequent ones, accompanied by so much and such violent pain in the head, that I at one time feared the membranes were implicated. The last of these attacks was complicated with intractable iritis, which has resulted in the destruction of the right eye; since which his general health has been very much improved, and although still subject to epilepsy, the attacks come on less regularly, seldomer, and with less severity than formerly. It is not now uncommon for him to have all the sensations of an attack without losing his recollection. From circumstances which have since come to my knowledge, I am disposed to believe, that had the patient, in this instance, followed implicitly my instructions as to regimen, the case would have terminated more satisfactorily. I have advised a trial of the Digitalis in several cases since Mr. S. T. P.'s, but have not personally superintended the treatment, nor found it exercise the same decided influence which it did in that instance. I believe a young lady at Cambridge, for whom I have been several times consulted, is now trying it, but I have not as yet heard the result.

"Believe me, my dear Sir, yours very sincerely,

"E. Headlam Greenhow."

I will next relate briefly some of the cases in which I have seen the oxyde of silver useful. The first was in the person of a remarkably fine young man, about twenty years of age, full habit of body. The disease appears to have been induced in him by a change from an abstemious mode of living, pursued when abroad, to the full diet and rich wines found at the tables of the wealthy in this country. The first attack occurred in the day-time after a ball the night before, no bed, and strong ale for breakfast; it was ushered in with strong symptoms of inflammation of the brain, and treated accordingly. He suffered from the disease for fifteen years, with varying severity; the longest interval during the whole of that time was three months, but this only occurred once; the usual interval was two months, and then fourteen days; the number of fits at each period varied from four or five up to twenty; on one occasion he had a fit every two hours as the clock struck, for forty-eight hours. He told me that he had sometimes averted a fit by taking a deep inspiration. I asked him how he knew he was going to have a fit; he said by uneasy sensations about his chest and singing in his ears. And these warnings of approaching attacks have frequently enabled him to leave the room where he was sitting, before the attack came on. He mentioned to me that on one occasion after a series of attacks, on being addressed by any one, the observation addressed, instead of conveying the idea that was meant, gave rise to some other idea. Some time after the attacks he suffered dreadfully from spasmodic action of the respiratory muscles, the spasms recurring at about three or five minutes, giving rise to a sense of choking, which, after continuing for about three hours was followed by violent pain in the region of the heart; this was relieved by the following draught;—

Tinct. Hyoscyami. ʒj. Ant. Pot. Tart. gr. ss. Magn. Sulph ʒij. Mist. Camph. ℥j.

When the series of attacks were passing off, he usually had one or two half attacks; that is, he would be in a state of insensibility for a minute or two, but there would be no cry or convulsions. The mind was more affected by these than the complete attacks. There was no headache before the attacks, but more or less headache afterwards; when several occurred, then the pain would be violent. The memory was much affected, the intelligence blunted, the temper irritable. Every plan of treatment was tried and every medicine given; he travelled abroad with a medical man; he tried homœopathy for two years; he

tried mesmerism; but one of the most celebrated professors of this art declared his case unfit for it—incurable.

During the greater part of his illness he was on a farinaceous diet, meat diet invariably making him too plethoric; on the farinaceous diet his strength was immense, and he could walk from fifteen to twenty miles a-day with ease. He commenced taking the oxyde of silver in the month of October, shortly after having had five attacks at the usual interval of eight weeks; at the end of the next fortnight he had one slight attack, and he has never had another. The dose was one grain three times a-day, continued for two months, and then omitted for a fortnight, the conjunctiva being carefully watched, to observe any change of color. In addition to the oxyde of silver, he occasionally had the tenth of a grain of calomel with each pill, and also the following draught:—

Liq. Potass. ℥iss. Tinct. Iodin. co. ℥j. Spirit Æth. Nit. ℥iss. M. capiat cochl. min. j. bis in die ex cyatho parvo aquæ.

The compound colocynth pill occasionally at night, if the bowels were at all confined. The silver was continued, with the intervals of fourteen days, for twelve months. He has now been well nearly four years, and has quite recovered his mental activity. He has been closely occupied in a public office, and has gone through a good deal of anxiety; he has returned to a meat diet, but not to the use of stimulants; he is strong and well, but cannot take so much exercise as he could when suffering from the disease, and he does not feel the want of it so as to produce strong perspirations, which he then found much relief from.

The next case I give briefly in my patient's own words:—

Case 91.—"My first attack of epilepsy was when I was about eleven years old: I was bled at the time, and when I recovered my strength I was not put on any particular diet, or under any course of medicine.

"I had no return until I was nearly fifteen, although I had frequently felt symptoms of epilepsy.

"In the beginning of June, 1838, I had an attack. I was put on very strict diet, by the advice of Sir Benjamin Brodie—4 oz. of meat, 6 oz. of bread. My attacks continued, on an average, about every five weeks, for two years; during which time I abstained from beer, wine, and spirits, but did not rigidly adhere to the diet recommended by Brodie.

"At the age of seventeen, I took for a year powdered tin, given me by a lady, and had a cessation of attacks for nine months, but during that time I certainly often felt symptoms of an attack. I discontinued the tin, on a return of my old complaint, 21st Jan. 1841. On the 27th April of the same year I had an attack; again, July 24th; and on the 5th October. I observed no particular diet, but took beer and wine in small quantities.

"On 23d October 1841, I left England, and had no attack until May 1842; again in October 1842; and during my stay in the colony, I had them about once every three months. Had an attack 5th of July (the day I landed), and on the 13th of August.

"1844.—I consulted Mr. Solly for the first time on the 8th of July, and since the 13th of August 1844 have had none of the feelings which I considered attacks or warnings of an attack."

Treatment.—Began Argent. Oxyd. gr. j. t. d., July 8th, 1844; July 5th, an attack; one on 13th August. Argent. Oxyd. gr. xxij. Hyd. Chlorid. gr. iij. in Pil. xij. Sumat. j. t. d.

September 16th.—Pil. Rhei co. gr. vij. Cal. gr. ij. h. n. Hs. mane.

October 6th.—Added Ext. Col. co. gr. v. ad. gr. j Lingul.

November 8th.—To discontinue silver, having taken it four months; has had no attack since August 13th.

January 12th, 1845.—Has had no symptoms whatever of an attack; returned to the use of the silver in this form. ℞. Argent. Oxyd. gr. xxiv. Ext. Col. co. ℈j. Cal. gr. ij. Conf. Q. s. fiat Pil. xx.

April 9th.—To leave off Argent. Oxyd., and take a purgative; feels quite free from all symptoms.

18th.—Weak; loss of appetite; to take Quinine and Ferri Sulphas. gr. j. t. d.

June 24th.—Feeling perfectly well, he discontinues these pills in about a week.

June 1847.—Continues perfectly well, and is now living in South America.

In the next case the fits disappeared under the use of the oxyde of silver.

Case 92.—Miss S———, æt. 30, of fresh complexion, had suffered from epilepsy for six years. It came on after the subsidence of an attack of rheumatic gout; her general health is good, and she menstruates regularly, but suffers a good deal of pain during that period; she has no leucorrhœa or headache either before or after; her memory is not at all affected, and she has no warning when an attack is coming on; she used to grind her teeth in sleep, but does not do so now; she has had three attacks in the last eight weeks, but previous to that had an interval of six months; a fit does not last more than eight or ten minutes, and they are shorter in duration than they used to be, and less violent; they recur more frequently in the night than day; the last happened last Sunday, when she was at chapel.

On the 27th of September 1844, Miss S——— applied to me for medical treatment, she suffering at the time from attacks of epilepsy. I ordered her to take ℞. Argent. Oxyd. gr. j. Conf. 28, ut fiat Pilula, b. d.

Oct. 28th.—Her medicine was altered to Pil. cap. ter in die.

Dec. 19th.—Has continued the medicine regularly up to this time, but had an attack between twelve and one o'clock on the 5th inst., and also on the 13th in the morning about seven; she was ordered to leave off the Pil. for a fortnight, and take ℞. Liq. Potassæ ʒiss. Tinct. Iodine co. ʒj. Sp. Æther Nit. ℥j. mist. cujus sumat. coch. min. et cyatho vinoso aquæ bis in die.

Jan. 2d, 1845.—She was not better, and the Oxyd. of silver was recommended.

Feb. 20.—The patient has continued to take her Pil. ever since the last date, but not quite regularly during the last fortnight. Ordered to continue them b. d.; she has suffered lately from slight palpitations of the heart.

April 19th.—She has had one slight attack in the night. Ordered to continue the medicine as before.

May 5th.—Much the same; to take her Oxyd. three times a-day.

6th.—She had another slight attack in the night, but it only lasted a very short time.

13th.—Has had a half attack.

27th.—To continue the medicine as before, three times a-day; has had no further attack.

28th.—The patient had an attack in the night.

June 6th.—There has been no fit since the last date; she was ordered to leave off the Oxyd., having taken it for five months fourteen days, and ordered to resume the mixture of Liq. Potassæ, &c., instead.

July 5th.—Has had a very slight attack in the night; the medicine to be continued.

Aug. 13th.—She has had no further attack; the Oxyd. to be resumed.

Sep. 24th.—Has continued the pills six weeks, and has remained quite well; she is much distended in the stomach.

Oct. 15th.—Ordered to leave off the Argent. Oxyd., there being some slight appearance of blue upon the conjunctiva.

22d.—She has had a very slight attack this morning, which lasted a few minutes, and she has since slept for two hours; a very short time after she was enabled to resume her employment of drawing. She says she feels much better than she usually does after an attack.

25th.—Ordered to resume the Oxyd., though the conjunctiva has quite a blue tint.

June 23d, 1847.—She has had continued health up to this time, having had no attack since April 1846.

In the next case the Oxyd. of silver exhibited great power over the fits; but I was obliged to abandon it in consequence of its tinging the skin.

Case 93.—April 13th, 1846.—Jane Brown, æt. 24, single, healthy looking,—her countenance not at all indicating any cerebral disease,—states she has been subject to fits of an epileptic character ever since she was nine months old; they then attacked her; sometimes there was an interval of nine or even twelve months between: they continued to attack her, with these long intervals, till about seventeen or eighteen; they then came on much more frequently, sometimes only a fortnight, and at other times there has been too and three months' interval. The longer she goes without the fits, the worse she is when they do attack her. She has them now less frequently; her last attack was about three weeks ago; and when, after the weakness and general debility occasioned by the fits have passed off,

and her health and strength are returning, she is again attacked. The fits are of a strong convulsive character, and last, with the intervals, three or four days, then, as before-mentioned, leave her weak and debilitated. She is regular; bowels in good order; and says if she could get rid of the fits she should soon get strong and well; has not been able to go to service on account of them. Ordered—Argent. Oxyd. Pulv. Acaciæ gr. j. ft. Pil. xviij. t. d. Nit. t. Cal. co. gr. v. h. s. Si alocis constipe t. d.

May 6th.—Has continued well; to continue the medicine.

26th.—She states that she is better this week, but that last week she had a pain in her chest, pointing to her stomach, and that this pain has usually preceded a fit, but that on this occasion it did not do so; continue the medicine.

28th.—She has not had any fit since she first consulted me; but her mother says she is now in fear of one coming on; because she has noticed that they are preceded by pain and soreness in her stomach and all across her body. No pain in her head. Her health in other respects is tolerably good. She has continued the pills regularly from the 13th of April. Argent. Oxyd. Pulv. Acid. a. gr. j. Ext. Cal. co. gr. j. Theriag. Q. S. ut fiat Pil j. ter in die sum.; bowels regular.

July 9th.—Has not had any fits since she consulted me; has taken Oxyd. three months. Ordered to discontinue it for a week.

23d.—Has not taken the medicine for fourteen days. On Sunday, the 19th, she experienced very uncomfortable feelings in the stomach, as if she was going to have a fit, but she did not lose her senses. She cannot describe the feelings, but she says they did not rise to the head as they do when they terminate in a fit. She had had some fresh currant pudding with her dinner.

She took some castor oil on the Monday about four or five o'clock, and after that began to act, she began to feel better, and is now feeling nearly well again, but not quite. Pulse 22, irritable. Ordered to resume the Argent. Oxyd. and to take Nit. Cal. co. if these feelings should recur.

August 19th.—Has been, on the whole, feeling well; but last Saturday and Sunday she felt pain in her stomach, and an uncomfortable faint feeling; but this passed off, and she has now a slight pain in her stomach. Ordered Bismuth Tris. Nit. gr. iv. t. d.

Sept. 22.—Has been taking the Bismuth since the 19th ultimo. She was not so well about the 17th or 18th of this month; but they did not communicate with me.

She had a fit on the 20th. Ordered to renew the Argent. Oxyd.

Oct. 15th.—Has continued well and more free from pain; a little dark under the eyes. To leave off for a week.

22d.—Says that for the first three days after leaving off the medicine, her stomach was uncomfortable; but that after taking an aperient pill it became all right. Ordered to renew the medicine.

Nov. 19th.—Feels well; no pain in the head; stomach comfortable; sometimes a little pain, but not much. Continue the medicine.

Dec. 2d.—No fit, but was very uncomfortable two days ago, as if she was going to have one, but it passed off, and she now feels pretty well. Ordered to continue the Argent. Oxyd.

1847, Jan. 4th.—Has had no more fits since the last report; looks very blue under the eyes, but not elsewhere. Leave off Oxyd., take Creosote.

12th.—The appearance of blueness has not increased; thinks that she has had more pain in her stomach lately, and some feeling of the fits. Ordered Bismuth gr. ij. t. d.

March 15th.—Decidedly blue under the eyes; a blue line on the gums of the lower jaw; had a slight fit on March 9th, during the menstruation period; interval nearly six months; the last on the 22d of Sept. Ordered Zinci Sulph. gr. ij. t. d.

31st.—Bismuth Nit. gr. iv. t. d. A severe fit yesterday; has been quite regular; it is now about the monthly period.

April 13th.—Much the same; slight uncomfortable feeling about the stomach. Creosote ♏j. b. d.

May 1st.—Had two fits just previous to the monthly period; the flow followed a day or two after; she had several half attacks, but not coming quite to a struggle.

10th.—Had taken no medicine since.

17th.—She is decidedly, though slightly, tinged with the Argent.; it is manifest below the eyes, and it forms a dark line on the edge of the gums; she has not had any return of the fits. As the last attack occurred just before the monthly period, I have ordered Ferri Sulph. gr. j. Zinci Sulph. gr. j. b. d. Nit. Aloes c. Myrrh gr. v. o. n.

I have found the shower-bath decidedly beneficial in epilepsy, and I am glad to find Dr. Watson giving his testimony strongly in its favor. He states that he has found more good from the vinum ferri than other

tonics. He enjoins total abstinence from stimulating liquors, and then goes on to recommend the olii terebinth. He says,* "You will find that most persons, in respect to that disease we are now considering, have some favorite or usual mode of treatment; and if I were called upon to name any single drug from which, in ordinary cases of epilepsy, I should most hope for relief, I should say it was the oil of turpentine. And I find that other persons have come to the same conclusion. Dr. Latham, the elder, was, I believe, the first person that made known its efficacy in this disorder. Foville states that he has seen excellent effects from it. It is highly spoken of by Dr. Percival in the Dublin Hospital reports. It is not given in large doses, but in small ones, frequently repeated; from half a drachm to a drachm every six hours. You are aware that it sometimes produces strangury, and, therefore, the patient must be forewarned of this or carefully watched. Occasionally turpentine has done good in virtue of its anthelmintic properties. I know that a physician of my acquaintance cured a case of epilepsy in this way somewhat to his own surprise. Without having in his mind any notion of worms, he thought it might be as well to purge his patient, who had labored for some time under epilepsy, with the oleum terebinthinæ. The patient, who was the brother of a person holding at present high office in this country, was residing some miles out of town. In the middle of the night the doctor was summoned to him in a great hurry; the messenger said he was supposed to be dying. He was only intoxicated, however, by the free dose of turpentine he had taken. The next morning he passed into the close-stool a large tape worm; he has never had epilepsy since. The late Lord Hardwicke, father of the present Earl, had epilepsy, and he, too, got rid of his epilepsy, and of a worm at the same time. I believe that the cure was effected by turpentine, but I am not certain of that. Such cases are remarkably interesting; they show that irritation of the stomach or intestines may be sufficient to cause the fit; they illustrate exellently well the eccentric form of the disease, and they deserve always to be borne in mind when we are asked to prescribe for an epileptic patient. A cure from so dreaded a complaint by such simple means, the cause of his malady, and the certainty of his having got rid of that cause, being both so obvious to the patient, may be enough sometimes to make a practitioner's fortune. But I think you will sometimes find the oil of turpentine very useful, even though it expels no worm, and there is no worm to expel: if the bowels should be costive, the oil of turpentine and castor oil go exceedingly well together."

I have not employed the turpentine, but I am not unfrequently consulted by patients to whom it has been unsuccessfully administered. In the following instance it had been given very freely by a very intelligent physician, but without any apparent benefit. The account of the case is in the husband's own words:—

Case 94.—"Mrs. P. S. for the last six years has been subject to violent sensations, which deprives her of all power of speech, though sensible of all that passes; they last for about two minutes; the muscles of the face are contracted, and a slight grinding of the teeth. But within the last two years, when the sensations have come on, and she has been *asleep*, she has gone from one of them into a true epileptic fit, which has shaken her very much;

* Medical Gazette, vol. xxviii. p. 376.

and for an hour after could hardly keep her from fainting; complaining of cramp in the calves of her legs, and violent pain in the head, and sickness; have generally given her a little sal volatile in water; she had one on Nov. the 9th, and again on Dec. 21st. The sensation came on again on Feb. 2, (but no fit,) they were stronger then than when she has had a fit. Mr. T., her usual medical attendant, cupped her about a year-and-a-half ago; but not more than a wine glass of blood came away; and felt very faint. The bowels in general very costive, and troubled with much wind at the chest; likewise troubled with a violent irritation at the rectum."

Remarks—Aged 45 years; had 13 children; violent flooding after the birth of each child; had several miscarriages; complains of great heat on the top of the head and over the eyes; youngest child twelve last July; two miscarriages since; the last is about ten years; it is five months since she had any show.

March 6th, 1847.—Pulse 16; dose ʒij. h.

7th.—Pulse 14, 18. ʒiij.

8th.—Pulse 14, at eight in the morning, 16, at half-past eleven. She says that after taking the medicine last night she felt very faint. Her husband, who felt her pulse, says that it was 15 and 16 in the quarter; but irregular in force and frequency, and slightly intermittent. She says she felt very much as she has felt after a violent flooding. If she attempted to raise herself in bed she felt a numbness all over. She did not feel unusually cold, though she suffers generally a good deal in that respect.

9th.—To leave off the Digitalis and take Zinci Sulph. gr. ij. b. d. Nit. Purgans o. n.

16th.—Leave off the Zinci, and take Argent. Oxyd. gr. j. ter in die. Liq. Magn. Inf. Rhei ℥ss. Tinct. Aloes co. ʒij. Tinct. Card. co. ʒj. o. n.

20th.—One fit. Loss of limbs for above an hour.

23d.—Continue the medicine.

April 14th.—Argent. Oxyd. gr. j. Hydr. c. Creta gr. ss. ter in die.

May 10th.—Has been taking warm-baths twice a-week; has been more comfortable since.

Last Thursday week, April 30th, complete attacks, and several slight ones.

Pulse 18. Looks decidedly better—more cheerful.

31st.—Has continued the warm baths three times a-week; is wonderfully improved in appearance; looks cheerful, and countenance not so pale; has continued the Argent. Oxyd. gr. j. bis in die. No fit of any kind. Says she is much better.

"June 11, 1847.

"My dear Sir,—I am in hopes there is an improvement in Mrs. P. S.; she has not had a fit at present, and not more than three of the sensations; but still there seems something lurking about her; at night she is very restless, and complains of feeling very faint; whether there is anything in the mixture or not, that causes it, I cannot tell, but will call upon you on Monday."

June 16th.—Says she has less of the sensations, and that they now pass off with a slight perspiration about the eyelids. Still troubled with a feeling of wind in the stomach. Ordered Bismuth gr. v. Ext. humuli gr. iv. Not more than five semi-attacks in a week; very slight struggle; not insensible for more than a minute and a half; they used to occur seven or eight in the day.

July 3d.—Feels altogether much better; does not suffer so much from the faintness; has left off the warm baths, but has continued the Bismuth. Bowels act more comfortably, as she has taken more exercise. Pulse 21, 20. Tongue clean; does not sleep altogether well at night; wakes about one, and kicks about, stretches, moans, but has no headache. Argent. Oxyd. gr. j. Opii. gr. $\frac{1}{8}$. Ext. Col. co. gr. iij. M. pil. ter in die sum.

Organic Diseases of the Brain.—By organic diseases of the brain, I mean all those morbid growths from the neurine of the encephalon or its membranes, which are not the result of simple hyperæmia of these structures. These may be divided into malignant or non-malignant, according to the sense in which these terms are generally employed in speaking of morbid growths in other organs; though we all know too well that all morbid growths within the skull are almost always sooner or later fatal, and thus equally malignant.

The consideration of these tumors is extremely unsatisfactory both in a therapeutical and physical point of view. In other regions all tumors are highly interesting to the surgeon, both medically and chirurgically;

but here he feels that medicine and local applications have but little power, and that the knife is of no use.

Regarding the treatment of these tumors, there is not much to be said, though I agree with Dr. Abercrombie that we should not consider them all as hopeless. The system must be kept rather low, but not so as to impair the general health. Mercury must be employed, but in such doses that the use of it may be continued for many months. The iodide of mercury is of great value in these cases if it does not disturb the general health.

In a physiological point the innumerable histories of these cases are valueless, from the want of accuracy in their detail and the impossibility of ascertaining the limits to which the influence of any tumor within the skull may be excited. I shall therefore confine myself to a very brief outline of this division of our subject. Under the head of organic diseases of the brain are included those of the membranes also. The first of these that we have to consider are sometimes peculiarly interesting to the surgeon; I allude to those tumors of the dura mater which, perforating the skull, make their way outwards. Such is not often the progress of cerebral tumors, but there are several on record. Dr. Abercrombie refers to them in the following words:*—"Tumors of this kind sometimes arise from the external surface of the dura mater; in this case they have been frequently known to produce absorption of the bone, and to rise externally under the integuments of the head, so as to be mistaken for wens. Many cases of this kind are mentioned by the French writers. In some of them the disease seems to have been originally excited by injuries: and in others an injury appears to have accelerated the process by which the tumor was making its way through the bone. When these tumors have been rashly meddled with by incision, death has generally been the consequence." The surgeon is often required to decide on the nature of tumors on the head both as regards diagnosis, prognosis, the propriety of operative interference, and other plans of treatment.

M. Louis, who was Royal Professor of Physiology, senior Surgeon to the Hospital de la Charité, and perpetual Secretary of the Royal Academy of Surgeons, Paris, was one of the first who pointed out the nature of the penetrating tumors of the dura mater. His paper is published in the thirteenth volume of the Memoirs de l'Académie Roy. de Chirurg., 1784. He states that the profession mistook the nature of these tumors, because they could not believe that a soft substance, such as these tumors, could penetrate a hard substance like the bones of the skull. "But," says he, "does not nature show us similar phenomena in the human body? have we not seen aneurism of the arch of the aorta find its way through the substance of the sternum?" He relates twenty very interesting cases in a very graphic manner; most of them are not the result of his own observation, but collected from various sources; some are accompanied with drawings. The whole paper is worthy of perusal. In the first case the patient fell heavily on his buttocks, without striking his head, but still he felt it was disturbed by the accident,

* Abercrombie, p. 313, op. cit.

and he had great difficulty in rising. The accident was not accompanied with any pain; but the disturbance of the dura mater appeared to last for four months, and then insensibly disappeared. After a perfectly quiet interval of four months, or thereabout, one morning when his barber was shaving his head he perceived a singular sound elicited by the razor, like the crackling of dry parchment. The barber remarked it to his customer, who tapping his head at the same spot also perceived it. At this time there was neither depression nor elevation. On the following day a small tumor appeared about the size of half-a-crown, a little raised, and with a pulsatory movement. The tumor increased slowly, and the first opinion which he obtained regarding its nature was, that it was an aneurism; a bandage was ordered, but he could not bear the pressure, which easily made it disappear, but gave rise to such giddiness that it frightened him. He was seen by a great number of surgeons; some of them adhered to the idea of its being an aneurism; others thought it was a hernia of the brain; but "the greater number," says Louis, "suspended their judgment, not wishing to expose it on a disease that they regarded as an extraordinary affair." It increased to the size of a turkey's egg, having the singular peculiarity, that pressure on it removed the pain, which Louis accounts for by supposing that the pain was occasioned by the pricking of the sharp points of bone from the edge of the opening in the skull. But as loss of consciousness was the effect of the pressure, he preferred the pain to the remedy. He died on the 17th of April, 1763, about two years and four months from the time of the accident.

The tumor was not even adherent to the skin; he simply says that the tumor was covered by a distinct membrane, and of the same consistence as the ordinary sarcomatous tumors, without elasticity or fluctuation at any part.

We must not be tempted to follow Mons. Louis into his account of the other cases. The termination of his paper is characteristic of the man, and teaches a lesson which may apply as well to the present times.

"I have endeavored, in writing this memoir, to follow the precepts laid down by Chancellor Bacon, in the second part of his great work on the remodelling of the sciences, entitled, 'Novum Organum Scientiarum;' in which he says that an exact observation of facts, and a correct and careful induction, is the true method of understanding and interpreting nature. To use this induction, says this great man, there must be a sufficient number of examples and facts collected with exactness, and shown with fidelity; then, considering these facts in every possible light, to be assured that they do not contradict one another, we may be secure of deducing some useful truth, which will lead to new discoveries. By this mode of proceeding, experience and reason together assist and enlighten one another. The Academy of Surgery has always adopted these principles; it only recognizes as theory that which is based upon facts; examples must follow all rules, and must apply or rather must form them."

The brothers Wenzel were the next who published facts in confirmation of those of Louis; and it is now universally admitted that fungoid

disease of the dura mater will sometimes cause absorption of the bones of the skull, and appear externally.

Cruveilhier* divides cancerous tumors of the dura mater into two classes: the one formed at the expense of the external layer, the other of the internal. The latter are the most frequent. There are also tumors which originate in the sub-arachnoid cellular tissue, and then, causing adhesion of the two layers, it becomes difficult to say from whence the disease first sprung.

But more numerous still are those encephaloid tumors which spring from the tissue of the bone, and generally from the diploe. Cruveilhier has given some excellent drawings of all these various kinds. In the Museum of St. Bartholomew's there are several very good specimens of the disease, but only one that can be unequivocally pronounced as springing from the dura mater alone.

Dr. Walshe has shown that these perforating tumors of the cranium are not confined in their origin to the above-named tissues, but they may spring from the pia mater and cerebral substance; and that the subpericranial cellular tissue also occasionally forms the nidus of this disease.

Cancer in this region, says the above writer, is rarely attended with development of the disease in other parts. Among sixty cases, Velpeau only found three in which other organs were similarly affected.

The history of the progress of these tumors seldom throws much light on their real nature and origin; for even those which proceed inwards often attain a considerable size before they produce cerebral disturbance; and those which perforate the skull generally proceed in that direction at once. Their size is no guide to their nature; they have been found to vary from that of a nut to that of a second head: neither is the bony ridge which generally surrounds them, any indication of their nature, for the most innocent tumors are occasionally thus imbedded. Within the last year I have had two cases under my care in St. Thomas's Hospital, of simple sebaceous tumors beneath the pericranium, which had formed for themselves a complete cup. One was about the circumference of a large orange; it rose but little above the surface of the cranium, and this was surrounded by a rough ridge, at least a third of an inch in depth. The tumor was soft but elastic. I removed it carefully, and then found the skull completely depressed, forming a hollow cup at least half an inch in the centre. The bone was bare, but quite firm and sound at the bottom.

What guide, then, have we to the cerebral origin of these cranial tumors? The following are tolerably certain, but they are not so unerring that, when absent, the question can be considered decided—indeed, the surgeon cannot be too careful in operating—it is of no use touching those which are cancerous, whether inter or extra cranial; two different pulsatory movements, and the effect produced on the sensorium by pressure. The two pulsations are occasioned by the heart's action, and the respiratory movements which more or less affect the brain: they are not usually very tender to the touch, though they are the seat of those

* Anat. Pathol., liv. viii. p. 2.

sharp pains which generally attend the growth of cancerous disease. When ulceration takes place, the real character of the disease is unmasked, and no one can mistake it; but death generally ensues before this stage is arrived at.

There is no portion of the dura mater in which these tumors are not occasionally found, varying, of course, in their effects according to their situation. They have been found attached to the falx and the tentorium. Andral relates a very interesting case of osteo-fibrous tumor attached to the tentorium, which by its pressure on the left lobe of the cerebellum caused much diminution in its volume, and changed its natural texture into one of extraordinary hardness. The immediate cause of death was an apoplectic effusion into the cerebrum.* The tumor was apparently owing to a blow received four years previous to death. "Immediately after the fall he experienced no uneasiness; subsequently, however, he began to feel a dull pain towards the left part of the occipital bone, which continued for a considerable time without becoming severe. Giddiness occurred also from time to time, often followed by total loss of consciousness, which never continued, however, beyond a few minutes. At a later period new symptoms presented themselves; on a sudden the upper extremity of the right side was attacked with a painful, and, as it were, tetanic shock. Five or six of these shocks rapidly followed this, and during the three or four days following the right arm continued torpid, and somewhat weaker than that of the opposite side. At first there were intervals of months between these attacks; they then became more frequent, re-appearing every ten or twelve days, uniformly limited to the right arm; and at the same time paralysis of this limb, at first transient, but becoming permanent and more and more complete. Insensibly also the right lower extremity lost the power of motion; it never, however, exhibited any convulsive movement."

Dr. Walshe, in his admirable work on Cancer, says†—"Cancerous productions occur in the brain in both the tuberiform and infiltrated forms. The size of tumors and extent of infiltrations is subject to much variety; nodules not larger than a pea are met with, as well as masses almost filling the place of an entire hemisphere. Tumors of medium size are, however, most common. In the majority of cases the brain is the seat of but one cancerous growth; several are, on the other hand, discovered in certain instances. Cancerous tumors appear in some cases actually continuous with the surrounding brain; in others they are said to be separated from this by cellular membrane, assuming the character of a cyst in a third class of cases, without being cut off from adjoining parts by a pseudo-cyst, they yet seem deficient in intimate connection with the natural tissue around. The last mentioned is the most common condition. The left and right hemispheres seem to suffer from the disease with very nearly equal frequency; both hemispheres are seldom implicated, and scarcely, as far as I have ascertained, except when the cerebral affection is secondary. In nineteen cases, I find the disease to have been seated in the left hemisphere in nine, in the right hemisphere

* Andral, p. 2, op. cit.

† The Nature and Treatment of Cancer, by Walter Hoyle Walshe, M. D., 1846, p. 888.

in eight, in both hemispheres in two. In nineteen cases, the lobes affected were—the posterior in four, the middle in nine, the anterior in four, the anterior and middle in one, all three lobes in one. In one of these nineteen cases the optic thalamus, in two the corpus striatum, and in one both these parts were the seats of the cancer. I have met with one example only of implication of the convolutions as an apparently primary state, and none of limitation of the disease when primary to those parts; they appear to suffer but rarely by extension of cancerous infiltration from adjacent textures."

Cancer is found both as a primary disease of the brain and a secondary one. Not a few cases are on record where every other organ in the body was healthy except the brain. Its progress is variable, sometimes rapid, though not generally so. Its presence is generally indicated by the inflammation which it induces in the surrounding substance or in the membranes.

The following case, which I related in the Medical Gazette in 1832, illustrates the progress of this disease, and shows its insidious character. It also is an instance of the cause of death, being the inflammation and serous effusion occasioned by the tumor, and not the tumor itself. It is interesting also from the rarity of this form of cancer in the brain, but especially in a child:—

Case 95.—*George N——, aged four years and three months. This child, after having been inactive and sleepy for several months, was seized, on the 9th of August, 1831, with an epileptic fit, which lasted some hours, but was ultimately relieved by venesection, leeches, and purgatives, with cold applications to the head. His stools were at this time without bile; urine high colored, and notwithstanding the daily use of the mercurial ointment and calomel, with scammony, until the 24th (amounting to 60 grains of calomel, and 1 ounce of ung. hydr.), no change was effected in the secretions; and after that, aloes were resorted to, when the stools immediately assumed a natural appearance, and the urine lost its high color, and the child was apparently well. Medicine soon after discontinued; but, however, before long, he again gradually became sleepy and forgetful: and he would frequently lay his head down, as if it were too heavy to support. For the last two months previous to his death, his intellect seemed impaired, though not to any great extent. He occasionally forgot words when he was speaking, and paid very little attention to passing events, though he always understood what was said to him.

On the 19th of February, 1832, medical aid was again sought. Bleeding, purgatives and blistering were directed; but the parents, feeling convinced of the inutility of these measures, declined adopting them. He died on the 24th, having laid two days in a state of coma.

Post mortem appearances.—On cutting through the dura mater, the brain bulged out through the incision, being evidently distended. The convolutions were slightly unfolded, and the sulci between them partially obliterated. Neither the arachnoid, pia mater, or substance of the brain, were more vascular than usual. The right lateral ventricle was found distended by fluid; the septum lucidum bulged in from the pressure of the fluid in the opposite ventricle; the arachnoid lining the ventricles was much thickened; the quantity of fluid contained in both ventricles was about six ounces.

On proceeding with the section of the left hemisphere, a tumor was discovered in the posterior lobe; it was about the size of a hen's egg, but not perfectly homogeneous in its texture; the most external portion looked as if it consisted merely of a deposition of fibrin, situated in which there were many vascular points, and also small irregular patches of a thick yellow fluid, varying in size from a pin's head to a pea. This deposition formed a sort of coating round the central tumor, which was as large as a pigeon's egg; though its edges were not distinctly defined, it was nearly as firm as cartilage, of a pearly gray white color, slightly granular on section, with claws, as it were, shooting out from the centre; it was separated from the posterior cornua by a very thin layer of medullary matter, and the thickened arachnoid which lined the ventricle. The rest of the brain perfectly healthy.

* Med. Gaz., x. p. 191.

The non-malignant tumors and membranes of the brain are the fibrous, osseous, tubercular, hydatid, steatomatous, fleshy or kidney-like tumors: all these various morbid products have been found by different pathologists. Dr. Copland has given a very full and learned account of them, which I shall not attempt to approach ; of all these deposits in the brain, the tubercular are the most common, especially in children, though it is not so frequently found in this situation as in the lungs or the lymphatic glands. It presents the same physical and microscopic characters in the brain as elsewhere. The situation of it in the brain varies much, but it is not so frequently found in those parts which are most frequently attacked with inflammation, namely, the hemispherical and other cerebral ganglia. It is found in the tubular neurine of the hemispheres, cerebellum, crura, pons Varolii, &c.

Dr. Bright frequently met with them in the cineritious neurine, but I think that this is not the general rule.

Dr. Hennis Green, in an admirable paper on this subject,* points out its frequency in children as compared with adults. Cruveilhier never saw an example in advanced life. Louis met with only a single case in 117 cases of phthisis among adults. And Lugol assures us that in his extensive practice at the Hospital of St. Louis, he has seen only eight cases of the disease ; in four, the tuberculous matter occupied the cerebrum ; in three the cerebellum ; and in one the pons Varolii. In six of these eight cases no symptoms existed during life ; and M. Lugol affirms, "that the diagnosis of cerebral tubercle is involved in the greatest obscurity." Dr. Abercrombie only relates one case from his own practice, which occurred in a man thirty-four years of age. "In children, on the contrary," says Dr. Hennis Green, "tubercle of the brain is, comparatively speaking, a frequent affection. I have observed one case to every fifty-one in 1324 cases of acute diseases." In seventy-five cases this author found that they had occurred most frequently from three to seven years of age. Tubercles vary in size, from that of a pea to that of a large egg ; in number, from that of a single mass to that of fifty.

"In no instance," says the same author, "was the affection confined to the brain. Tubercles or tubercular deposit were invariably found at the same time, either in the thoracic or abdominal cavities ; but in several cases the greater development of the tubercles in the brain leads to the idea, that the disease commenced in the nervous system."

Tubercle in the brain generally destroys life, by exciting inflammation of a low sub-acute character. In children this is generally followed by effusion into the ventricles. It will often remain dormant for a time, and then suddenly alarming symptoms will appear, and prove fatal in a few days.

The following case is interesting in this point of view, and also in another, to which the attention of surgeons is very frequently directed, namely, whether by healing external strumous sores internal disease is excited. In this case the internal appeared to be dormant, while the external was going on, and as soon as the external was cured the internal disease appeared.

* Med.-Chir. Trans., vol. xxi. p. 192, read January and June 1842.

Case 96.—T. B. P., a child four years old, was under my care in St. Thomas's Hospital, with strumous disease of the elbow joint, but without any indication of cerebral disease, nor was anything told us by the mother to call our attention to the head. I ordered the Cod-liver Oil ʒj. t. d., and the Tinct. of Iodine to the chest, as I was a little fearful regarding the lungs. The elbow was firmly fixed by means of a pasteboard splint. The child's health improved in the hospital, as regards his appetite and appearance, but some superficial scars of old wounds ulcerated and became small sores; he was in the hospital about five weeks; the sores healed, and the elbow joint became free from pain. Soon after he left the hospital his health again declined, and he then complained of his head, but they had no advice for him until he was seized with a fit, about one month after leaving the hospital, on the 19th of March; it was slight, and only lasted a few minutes, but it was followed by others on the two following days: on the third day the child became quite insensible; in this state they brought him again to me. He had now all the signs of effusion on the brain; from these symptoms he never rallied at all, and died in four days from the time of his first becoming comatose. When the child was brought to me with signs of cerebral mischief, I learnt the following of his early history:—When about two years old he complained much of pain in his head, with disturbance of his bowels and enlargement of the abdomen, loss of appetite and general lassitude; by judicious treatment he got well, and remained so until about a few weeks previous to his coming into the hospital; at this time he was seized with a convulsive fit, which lasted six hours; he had four leeches behind the ears, warm bath, and purgatives. About a week after, the elbow contracted and became painful, the head being quite well and comfortable, so that when he came to the hospital nothing was said regarding his head.

Post-mortem examination, 24 *hours after death*. Weather cool. Membranes healthy; convolutions flattened; ventricles distended with serum to nearly three times their natural size. In the centre of the inferior vermiform process of the cerebellum there was a firm yellow scrofulous tubercle, about the size of a large marble; it was much harder than healthy neurine. The neurine immediately surrounding it was slightly softened, but beyond a hair's breadth it was all quite healthy. Lungs and heart healthy; as also the abdominal viscera.

The plexus choroides is sometimes the seat of organic disease. One of the most common changes in its condition is a consolidation and hypertrophy of its tissue. It is doubtful whether this fleshy appearance is the effect of repeated dilatation of its vessels, or a true morbid growth. I am not aware that it has been connected with any peculiar symptoms during life.

Still more frequently do we find this portion of the pia mater the nidus of small vesicular bodies like hydatids, but they are not so—they are merely cysts containing serum. Dr. Bright considers them as occasionally the predisposing causes of apoplexy.

Among the morbid adventitious structures which are met with in the brain, we must not omit to mention hæmatoma, as it has been designated by Dr. Hooper in his illustrations of diseases of the brain. It is doubtful whether this disease is anything but a form of fungus hæmatodes.

Dr. Hooper has given a very beautiful drawing of this disease, which he thus describes: "This tumor is fungous, and takes its origin from the medullary substance of the cerebrum near the ventricle, but has no connection or communication whatever with that cavity. It has a broad base, and in making its way outward has separated the convolutions of the brain to some distance from each other. Externally it is covered by the pia mater, over which there is a very vascular membrane, which is either the arachnoid altered by disease, or an adventitious membrane produced by inflammation. This fungus is irregularly lobulated. To the touch it feels soft and is somewhat elastic. It cut as firm as brain, and presented a vascular mottled surface, of a reddish yellow color, with portions here and there of a coagulated blood-like substance."

"The circumstances," says Dr. Walshe,* "most distinctly permitting the physician to affirm that a tumor exists within the cranium, are, the existence for a considerable period of intense cephalalgia, especially limited to a fixed point, or even to one side of the head, and if attended with repeated vomiting; of convulsive movements without paralysis, but followed by mere weakness, or actual paralysis of the affected parts; of different affections of the organs of sense, especially alteration of sight, and of disturbance of intellect, while the general health does not very materially suffer. But the previous details show that such a combination of circumstances will not very commonly exhibit itself."

Dr. Abercrombie does not attempt to connect any particular symptoms with the various forms of organic diseases, but he gives a very interesting outline of the principal modifications of these symptoms in the aggregate, of which the following may be considered as an abstract:—

First—Long-continued and severe headache, the pain varying both in seat and severity, sometimes occurring in *regular paroxysms*, leaving intervals of comparative or complete relief.

In some cases the pain is acute and lancinating; in others, obtuse; sometimes referred to a particular spot, as the occiput, or one temple. In the more violent paroxysms the pain is intense, obliging the patient to remain for a considerable time in one position, the slightest motion aggravating it to perfect torture; but the remissions from this severe suffering are often so remarkable as to lead a superficial observer into the belief that it is merely periodical headache, or headache connected with dyspepsia. Formerly the disorder of the stomach, which frequently accompanies these organic diseases, was supposed to be confirmatory of this view; but now medical men regard justly the vomiting which often attends these headaches as a most serious symptom, directing their attention especially to the brain. In vomiting from dyspepsia, the headache is generally relieved after the stomach has been emptied; but not so in these cases.

Secondly—In another form, after some continuance of fixed pain, the organs of sense become affected, as the sight, the hearing, the taste, and the smell; ptosis or paralysis of the upper eyelids ensues; and lastly, the intellect gradually becomes dull and the memory imperfect. All such symptoms must of course depend on the exact seat of the tumor; the loss of power in the different nerves depending on pressure either of the nerve or of its ganglion. When the tumor is seated so as to oppress the nerve alone, the loss of the use of the organ which it supplies will be the only result; but if the ganglion be affected, especially those of the optic and auditory nerves, a much more serious set of symptoms will rapidly ensue, such as convulsions and more or less general paralysis.

Thirdly—If the tumors happen to be developed in the tubular neurine, and not in or on any of the ganglia, the first indication of their existence will be an excitation of the muscular system, and the result of this excitation—convulsions. Sometimes these convulsions appear under the regular form of epilepsy, but generally more irregular; sometimes violent paroxysms of headache *precede* the convulsions, which are not usual in

* Op. cit., p. 495.

functional epilepsy. Tubercles in the cerebellum, in the tubular neurine of the hemispheres, pons Varolii, and crura, will give rise to these convulsions; also spiculæ of bone when they reach the medullary structure. Patients often die in the convulsions. If they are not rapidly cut off there is generally some paralysis of one or more of the limbs. There are some few cases where paralysis occurs, without being preceded by more or less convulsive action of the muscles, but this is not often the case in organic diseases.

Fourthly—There are a class of cases which I believe occur very rarely, but which Dr. Abercrombie describes in these words:*—"This class calls our attention to a train of symptoms which are referred to the stomach, but which really depend upon disease of the brain. In many of the cases of organic disease of the brain the stomach is affected; but those to which I now allude are remarkable from the affection in the stomach being the prominent symptom. In these there is often, through a considerable part of their progress, very little complaint of the head, or no complaint so fixed and urgent as to direct our attention to the brain as the seat of disease. There is generally, however, some pain or weight in the head, sometimes occurring in paroxysms like periodical headache, or in paroxysms accompanied by vomiting, like what is commonly called sick headache. The pain is increased by exertion, external heat, passions of the mind, and stimulating liquors; there is generally variable appetite, bad sleep, oppression of the stomach, and frequent vomiting. The vomiting sometimes occurs in the morning on first awaking, and sometimes at uncertain intervals, and very suddenly, without any previous sickness. There are in general uneasy sensations referred to various organs, by which the nature of the disease may be disguised in its earlier periods; but after a certain time symptoms referable to the head generally begin to appear, such as fits, loss of recollection, convulsive paroxysms, and affections of sight. After this stage of the disease death may occur suddenly in an attack of convulsion, or it may be preceded by a train of severe suffering. In cases of this class we must beware of being misled in regard to the nature of the complaint, by observing that the symptoms in the stomach are alleviated by a strict regimen, or by treatment directed to the stomach itself. If digestion be impeded, from whatever cause, the uneasy symptoms may in this manner be alleviated; but no inference can be drawn from this fact in regard to the cause of the derangement. In the earlier periods of this affection the diagnosis is indeed often very difficult. There is generally more permanent and fixed uneasiness in the head than we should expect to find in a dyspeptic case, and the uneasiness is increased by causes which would probably be beneficial to a dyspeptic headache, such as activity and cheerful company. The prominent morbid appearances in cases of this class seem to be in the cerebellum."

Fifthly—There are some cases which might at first be mistaken for apoplexy of a slight transient character, until the repetition of the symptoms rather frequently and without any great increase in severity shows that they cannot be dependent on effusion of blood; for when the effu-

* Abercrombie, p. 321, op. cit.

sion is repeated in the brain the second attack is almost always worse than the first, and so on. In some cases it consists chiefly of an habitual giddiness, which makes the patient afraid to walk alone; in others there are sudden attacks of all muscular power without loss of recollection, which are soon recovered from. Sometimes there are attacks of perfect coma, which may occur at regular or at irregular intervals, the patient having in some cases such warning of their approach that he goes to bed before the attack. There is usually more or less unsteadiness of the limbs, and generally, but not always, headache. In some cases there are affections of the sight, and these may either be permanent or occur in paroxysms; and in some cases giddiness and loss of recollection are excited by bodily exertion, and go off on desisting from it.

The following case illustrates very forcibly the fact that tumors of the brain may be formed and grow to a considerable size without giving rise to any striking cerebral symptoms until they excite inflammation in the surrounding cerebral substance. The subject of the present history I had known for many years, and was in the habit of seeing him frequently. He never complained of his head to me, though he used occasionally to consult me for slight ailments. Since his death I have learnt that he had not been quite so active as formerly, and that he used frequently to put his hand up to his head, but he never complained much, and attended to his business regularly up to the date of the attack now to be recorded. He used always to take a walk before breakfast, and appeared to enjoy life as much as other persons. I was guided in my treatment more by my previous knowledge of the general character of his constitution when in his usual state of health, than merely by the symptoms attending the onset of the attack.

Case 97.—May 20th, 1847.—I was requested to visit a gentleman, by his brother, who feared that he was threatened with an attack of paralysis. My visit was paid immediately, at 10 A. M. I found him lying on the sofa, in a sleepy state; he had only just risen, but he complained that he was so drowsy that he did not know what to do. He is stout and fat, and of lax, flabby fibre, æt. 46, residing at his place of business in the city, and taking very little exercise. Living well, and though not positively intemperate, still occasionally taking porter, and brandy and water, and cigars, before going to bed. This he has not done for the last few days. Last night he had some cheese for supper, and brandy and soda-water with it, about half-past 10; he went to bed about half-past 11. He says that he slept badly, dreaming a good deal, and that he awoke with headache. He has been slightly sick this morning; has not yet had any breakfast. His eyes are slightly, but very slightly, congested, the pupils perfectly natural; says his headache is over the forehead—thinks it is a little more on the right side than the opposite. The face is decidedly, though slightly, drawn to the right side; the tongue is protruded straight. He has no numbness anywhere. He says that he has no loss of power in either arm or leg. Feels sick, and inclined to vomit. His bowels have not been open this morning—he is not a subject to bear blood-letting; pulse 13 in the quarter, 23 in the half, 62—soft and full; hands and feet cold, as is usual to him.

Ord.—Leeches, xij. capitis dextri lateri. Seidlitz powder in infusion of ginger; feet in hot water.

5 P. M.—Much the same, the Seidlitz has not acted; complains of his head. Ord.—Enema Tereb. ℥j. ad lb. Hirud. xij. lotio frigida. Pulse slow and feeble.

10 P. M.—Much the same; no inclination for food; says his head is easier since the leeches; finds it more comfortable when it is rather low than high. Bowels not open; pulse 60, full and soft, quite regular; hands and feet warm. Ord.—Cal. gr. iv. 6$^{\text{tis}}$ horis. Emp Lyttæ nuch.

21st.—Has passed a restless night, complaining of his head; cannot bear to have it raised; the blister has been rubbed off repeatedly during the night. Bowels not opened; they are not generally obstinate; pulse 56, soft and regular; perfectly rational, answers immediately and distinctly; pupils quite natural; tongue furred in the centre, flabby and indented on the side; no inclination for food or drink.

Ord.—Cal. to be continued, and hair to be cut very short. Rep. Enema Terebinth.

5 P. M. Enema has returned immediately; bowels have not acted; head very uncomfortable, but the intellect intact; pulse 56; head hot.

Ord.—Olei Tiglii ♏j. Before this was given, the bowels acted. C. Cruentæ temporibus ad ℥viij.

10 P. M.—Better; head more comfortable. Ord.—Cal. gr. iv. bis 4tâ horâ postea 6tâ horâ.

22d.—Has had a better night; pulse 56, soft. Bowels open, urine abundant. Tongue cleaning; decidedly better; continue the calomel.

23d, 9 A. M.—Says he has had a better night; quite rational; head cooler; to continue the calomel.

3 P. M.—Bowels not open; rather more drowsy. Ord.—Infus. Senna ℥ij. Magnes. Sulph. ℥ss. Syrup Zinzib. ʒij.

8 P. M.—Very drowsy, but no stertor; answers rationally but slowly, and says his head is decidedly better; pulse 56, soft; bowels confined. Ord.—Enema Terebinth.

10 P. M.—Bowels opened; a good deal exhausted getting out of bed; very drowsy. Ord. to continue the calomel.

May 24th, 9 A. M.—Addressed me cheerfully when I entered his room; said he had a good night. The nurse says he slept well. Pulse soft and slow; tongue furred; mouth slightly tender; bowels open; has not taken any calomel since my last visit. Ord.—Gargarisma sodæ chloratis ℥j. ad ℥vij. Nurse says she has observed some convulsive trembling in his arms, but not more on one side than the other. He says his head is easy when it rests on the pillow, but that he cannot raise it without pain.

12 A. M.—Pulse 48, soft; cheerful; no change. Repeat Cal. gr. iv.

5 P. M.—Not so well; more drowsy; eyes congested; pulse 48; quite conscious, but says he only wants to be left alone. Feeling it was a question whether he would not be better for the loss of more blood, I sought a consultation with Dr. Cobb. He went into the case most carefully, and agreed in the propriety of cupping from the head. Suggested giving him a little ammonia, thus—Liq. Ammon. Acet. ʒiij. Ammon. Carbon. gr. v. Aq. distill. ʒj 6tis. horis. As his mouth is tender, we may suspend the calomel.

10 P. M.—Rather relieved by the cupping; pulse 52. Says his head is more comfortable.

25th.—Much better; cheerful; countenance improved, not so red; eye less injected. Continue the ammonia.

9 P. M.—Ord.—Pil. Aloes gr. viij. Hyd Chlorid. gr. ij. n. m.

26th, 9 A. M.—Bowels open; much the same. Continue the ammonia.

12 A. M.—Much the same.

9 P. M.—The nurse says he has been slightly wandering in his mind, asking repeatedly for brandy and water, and then talking about a party he had, and that his brother would be annoyed by the row they kicked up. She also said that he had been very restless, not sleeping at all. When I saw him, he answered quite rationally; but on the nurse telling him to ask me if he might have what he had been asking for, he said, "Brandy and water," in a sharp, snappish tone, unlike his usual manner. From this account, I judged that there was threatening of delirium tremens, and I determined to give him an opiate.

Ord.—Liq. Opii sed. ♏xx. Liq. Hyd. Bichlorid. ʒj. Aq. Menth. ℥j. h. n.

27th, 9 A. M.—Has passed a quiet night; dozing this morning. Nurse says he awoke rational this morning. When she asked him if he would have tea, he said, "No, not at present, some toast water." Much the same during the day. Continue the ammonia.

In the evening rather restless. Ord.—Liq. Opii ut antea.

28th.—Much the same. Continue the ammonia.

29th.—Mouth still tender from the mercury; tongue foul; very feeble when moving from one room to another; passes all his urine in bed, involuntarily; dozes and rambles.

9 P. M.—Has had a goood deal of twitching in the arms and legs; countenance not more drawn than before. Dr. Cobb saw him with me, and thought him rather better. We ordered Potass. Oxymur. ℈j. ex aq.

30th.—Went to sleep about 10, and therefore the nurse did not give him the Liq. Opii. He awoke about 2 o'clock, and was then restless, but he went to sleep again without any opium. When I saw him at 9 A. M., he answered cheerfully, but he was inclined to ramble. Pulse 56.

Ord.—Continue the Ammonia and Potass. Oxymur.

10 P. M.—Has taken more nourishment to day, but has been very restless, talking a great deal about whisky and water, sherry, &c. Has not slept at all during the day; has taken his draught, and is now asleep.

31st.—Much the same all day. Continue the same.

June 1st.—Better; more cheerful and more collected; set up during the day; eat a little meat for dinner. In the evening was quite silly, wanting to put his boots on, and go out; would not go to bed. They sent for me, and in my absence Dr. Cobb kindly attended. The

excitement of seeing him brought him to himself, and he went to bed quite quietly at half-past 10. At 11, I found him sleeping soundly, without any opiate draught. I ordered it to be given if he awoke, and was restless.

June 2d.—Cheerful and collected; has eat an egg for his breakfast; says he is much better. He awoke about 2 in the morning, took the opiate draught, and then went to sleep again. Ord. to continue the Potash, Oxymur. and Ammonia.

12.—Saw him with Dr. Cobb, in order to decide as to the propriety of giving him some beer with his dinner. He agreed, and we allowed it to him.

6 P. M.—All the better for the ale (Hodgson's).

3d.—Has had a good night. Awoke about 2, and took the opiate draught; has been able to retain his water since the 31st; pulse 60.

4th.—Continues to improve.

5th, 9 A. M.—Cheerful and collected; has passed a pretty good night.

3 P. M.—Mrs. B. complains that he has been rambling a good deal, asserting quite confidently that he had been at Dalston the night before, and showing delusions on other points. Pulse soft, 50. This incoherency passed off after he had his dinner; and when I saw him at 3, he was quite rational. I ordered him a meat supper, with another glass of bitter beer, and Liq. Opii sedative ♏xxx. horâ somni.

11 P. M.—Has been quite sensible all the evening; enjoyed his supper at 7; took his draught at 9; went off to sleep quietly. Slept well till 4; got out of bed to evacuate; returned again quietly and went to sleep, and slept till between 8 and 9.

6th, 9 A. M.—Found him cheerful and perfectly collected; pulse soft, 50; slept well.

℞. Infus. Calumbæ ℥v. Ammon. Sesquicarb. ʒss. Spirit Myrist. ʒij. Tinct. Card. co. ʒvi. M. ft. Mist. 6ta. bis die 11 A. M. and 4 P. M. This mixture was continued till June 17th.

℞. Liq. Opii sedat. ʒss. Mist. Camph. ℥j. M. ft. Haust. h. n. s. et repet. 3 si opus sit.

℞. Infus. Senna ℥iss. Magn. Sulph. ʒiij. M. ft. Syr. Zinzib. ʒj. M. ft. Haust. mane sum si opus sit. Two or three aperient draughts have been taken.

6th.—About 11 P. M. I took him nine miles out of town in an open carriage. He was quite himself; enjoyed the ride, and a mutton chop and pint of ale at the end of it. I left him then in other hands, with directions for the same plan of treatment to be followed.

10th.—Going on well in every respect.

12th.—℞. Pulv. Rhei. Pil. Hydrarg. a. a. gr. iv. M. ft. Pil. ij. nocte sumendus.

℞. Haust. Aper. ut antea, mane post pil.

℞. Sp. Æther Sulph. co. ℥ij. Liq. Ammon. Acet. ℥ij. Aq. Rosæ ℥iv. Aq. ad ℥xvj. M. ft. Lotio capite continue admovend.

15th.—Much better, having passed a tranquil night; he rose without much effort, and got down into the dining-room, about ten o'clock. Rested on the sofa for an hour; and the tone of his mind was evidently more healthy and natural, as he talked of his future prospects quietly, and seemed quite collected, except as to where he was, and the hour, &c.

Had the best part of a lamb chop, and a glass of bitter ale, at twelve, having taken a dose of tonic mixture at eleven. Walked round the garden with the assistance of an arm, for ten or twelve minutes, then came in and read the newspaper for a short time, and fell into a natural sleep for half an hour; awoke without the usual excitement, his pulse counting 53. He was quiet, but cheerful, and ate a bit of boiled fish, at five o'clock, and his second glass of ale, and after resting for an hour on the sofa, he walked on the common for more than a quarter of an hour without feeling tired. Had his cup of cocoa, and a little bread and butter, at eight o'clock, and went to bed at half-past nine. Bowels irritable.

16th.—Awoke with a very had headache, having had a restless night; he was scarcely able to sit up for the hair-dresser to shave him, after which operation he lay down on the bed, and was some time before he could finish dressing. His head continued very bad with what he described to the doctor as a "bumping" headache, ate a little meat, and had his ale, at twelve, after which he fell into a heavy sleep for an hour; awoke with much less headache, but the eyes bright, and pupils dilated, and his countenance vacant. He became restless; wanted his boots, &c., to go to town; inquiring of the servants where the omnibus went from, &c. For an hour and a half, his friends had great difficulty to keep him amused and quiet, but as it poured with rain, he could not then get out. He had some fish at five, and the weather clearing, he went for an hour's drive, when he got quite cheerful, and enjoyed it: after he came home again, became restless, and soon retired to bed.

17th.—I found him very drowsy, complaining of great pain in his head, which was hot, and the face flushed: pulse 40, full and laboring, occasionally slightly intermittent. It appeared to me very clear that we had now to contend again with the old mischief, and that from an anæmic state of brain, we had now an hyperæmic condition. I recommended the application of forty leeches, and the head to be shaved.

℞. Spirit Terebinth. ℥j. Mist. Cath. Com. ℥iv. M. ft. Mist. pro Enema.

℞. Hydrarg. Prot. Chlor. gr. ij. sit. pulv. 3tiis. horis sumend. Mitte viij. Enema Terebinth.

He was so restless, that not more than fifteen leeches were applied.

18th.—Impossible to rouse him, either for his breakfast or the hair-dresser: he had been restless and wandering all night, with occasionally heavy sleep. His bowels had been very inactive, although pills, &c. had been given at night. He remained in that drowsy state till two o'clock, when he slightly improved; at three o'clock a dose of Croton oil, ♏ij. was given, and another at six o'clock, after which the bowels were relieved, and he rallied wonderfully, his hands and feet becoming warm, and his pulse rising to 60. Was not able to get up at all.

℞. Hydrarg. Prot. Chlor. gr. iij. Sacchar. gr. v. Ol. Croton. ♏ij. M. pro pulv. statim sumend. 1 P. M. et repet. post horas tres. Mitte ij.

19th.—Awoke without much pain, having slept tolerably, but his ideas confused, and great exhaustion all day. Slept heavily, and had no appetite, and about six o'clock in the evening had most violent pain, more particularly in the right side of the head, which lasted till twelve at night, when he became exhausted, and fell into a good sleep for an hour or two; was quite conscious and collected while in the violent pain, but became wandering and confused when it subsided. Bowels inactive.

20th.—Awoke from his sleep so exhausted he could hardly speak, but perfectly sensible. In the afternoon, took some pills, after which his bowels were much relieved; but he was so weak he could not stand, even with the assistance of two persons, nor take any nourishment. Not much pain in his head, and he was evidently suffering from exhaustion.

℞. Ol. Croton ♏ij. Ext. Coloc. co. gr. viij. M. ft. Pil. ij. statim sumend. (11 A. M.)

℞. Potass. Bicarb. ʒij. Aq. Distillat. ℥viij. M. ft. Mistur. Alkalin.

℞. Acid Citric ℈iv. Aq. viij. M. ft. Mistur. Acid. Cap. Coch. amp. duo sing. dosis. Mistur. Alkalin. 2dis. vel 3tiis. horis in actu effervescentiæ.

℞. Liq. Opii sedat. ♏xx. Conf. Arom. ʒj. Aq. Cinnam. ʒvij. M. ft. Haust. Signa. the soothing draught. Mitte ij. One taken early in the morning of the 21st.

21st.—Had been restless from the irritability of his bowels, but slept heavily towards morning, and continued in a heavy, drowsy state, but conscious (though unable to speak) when he was roused to take nourishment, or medicine, which he swallowed at all times with difficulty, and sometimes could not swallow at all.

8 P. M.—I found him sleeping, and spoke to him, and with difficulty got him to put out his tongue: he did not open his eyes, but on my asking him if he knew me, he nodded his head, evidently recognizing my voice. About an hour afterwards, he was unconscious, and I could not rouse him at all: head rather hot; pulse 40, soft and feeble.

We agreed that he would not bear any kind of depletion, but that we would try and stimulate the kidneys.

℞. Ammon. Sesquicarb. ʒss. Tinct. Cardamom. co. ℥ss. Syrup Aurant ʒiij. Sp. Myrist. ʒj. Aq. Anethi. ℥iv. M. Capt. Coch. j. amp. omni hora. Commenced about mid-day, and continued till 6½ P. M.

℞. Acet. Lyttæ ℥j. pro capitis applicatione.

℞. Potassæ Bicarb. ʒiss. Sp. Junip. co. ℥ss. Tinct. Lyttæ ʒj. Syrup Aurant. ʒij. Aquæ ℥viij. M. Capt. Coch. amp duo statim et 3tia. vel 4ta. q. q. hora sumend.

22d.—Passed a tranquil, heavy night, without much natural sleep, but was somewhat better in the morning: bowels quite inactive: towards the middle of the day, roused a little, took his medicine, but very little nourishment during the day, and the face became hectic on the cheeks. The application of tinct. lyttæ took a slight effect on the forehead, but none on the head. Very drowsy, but sensible when asked a question, although hardly able to articulate an answer.

7 o'clock.—Pulse 50, yawned and shuddered a good deal, moving his arms upwards, and grasping anything within his immediate reach. Bowels still inactive Became still more restless, with the hands moving constantly towards the head, breathed with difficulty, and between 11 and 12 at night had a troublesome cough, with difficulty of breathing. Pulse low and fluttering, and was certainly unconscious: passed a tolerable night, alternately restless and heavy; took half a cup of beef-tea, in spoonfuls; but the pulse rather better on Wednesday morning.

23d.—Pulse 55; face still red, but did not complain (when asked) of pain, anywhere, except the right hand; continued tranquil, and conscious when spoken to.

2 o'clock.—Pulse 60; remained in a complete stupor, and without action of the bowels.

10 o'clock.—Had a simple enema, which had a moderate effect, and relapsed into the same state in which he bas remained all night. He has taken a few spoonfuls of beef tea, and his stimulant medicine, as ordered. His right hand is rather swollen, but does not seem in so much pain as yesterday. His eyes have but once been open since Sunday.

24th.—Pulse 48; comatose all day.

25th.—At 2 A. M. this poor sufferer was released, after a most severe struggle.

Post-mortem, 28 hours after death, temperature 60:—

External appearance.—Ecchymosis from gravitation on the posterior part of the head, neck, and body, generally: the blood-vessels of the scalp not particularly full.

Internal appearance.—Vessels of dura mater very full; bled freely after tearing off the skull—and the skull itself rather thin and vascular; convolutions flattened by pressure of the skull; veins of pia mater full; brain generally full of blood; cortical substance rather darker than usual, but not inflamed; all the ventricles very much dilated, especially the descending cornua; fifth ventricle also very large, containing nearly a drachm of fluid; section on a level with the corpus callosum natural. On making an incision into the right hemisphere, on a level with the upper part of corpus striatum, a difference in the color presented itself, in the medullary substance; this was a diffused yellowish stain—the texture softened; on slicing the brain a little further, and dissecting the whole carefully, it proved to be ramollissement of the medullary substance surrounding a distinct fungoid tumor. The softened brain was about the sixth of an inch in depth, and was of a reddish color as it approached the tumor. The tumor was the size of a pullet's egg, nearly circular in form, medullary fungus in texture, contained in a distinct cyst. It was situated in the medullary substance of the right hemisphere to the outer side of the corpus striatum, and to the inner side, and in contact with the convolutions of the Insula of Reil in the fissura Sylvii. Thoracic and abdominal viscera healthy.

Hypertrophy of the Brain.—It is now a well-established fact that the brain, like the heart and other organs of the body, occasionally becomes hypertrophied. The neurine which composes it is actually increased in quantity; but this increase is not so clearly the effect of the undue exercise of the organ as the hypertrophy of the heart. When the heart is hypertrophied it can generally be accounted for by its having had double duty to perform in consequence of some obstruction either at the commencement or in the course of the arteries, or some other circumstance which has called its powers unusually into play, such as a defective condition of the valves. But this is not so clearly proved with regard to the brain. Still it must be allowed that as the disease generally occurs in childhood while the brain is still growing, and there has been a certain degree of intellectual precocity in some of the cases on record, there is sufficient evidence to use as an argument against the early stimulation of the brain.

There can be no doubt that many a child has been sacrificed in early youth to the pride of parents, who, delighted with the intellectual activity of their children, have striven to make them prodigies of learning. But in these cases of early and undue employment of the brain, inflammation of the hemispherical ganglion, or of the lining membrane of the ventricles with serous effusion, has usually been the cause of either a fatal issue or of subsequent mental imbecility. The late Mr. Deville related to me an interesting case of this kind. An extremely intelligent boy, of about twelve years of age, was brought to him for phrenological examination by a parent who was very proud of the intellectual endowments of his child. Mr. Deville gave his opinion of the boy's character, at the same time cautioning the father of the dangerous course he was pursuing. But the father's reply was, "all that other boys considered labor and hard study are mere child's play to him; that his studies could not be hurting him, he enjoyed them so much." Again, Mr. Deville endeavored to save the child, but the father would not attend to the warning. Two years from that time the father again called on Mr. Deville, and in reply to his inquiries after his child the father burst into tears—his child was an idiot.

Hypertrophy of the brain is easily recognized after death, in consequence of its immediately bulging out the dura mater as soon as the skull-cap is removed. The texture of the brain is so extremely elastic and compressible that as soon as the box is opened it rises up, showing most unequivocally that it is too large for its containing cavity. The hypertrophied brain is always unnaturally hard, and the tubular structure almost bloodless. The blood-vessels have evidently been so compressed that their cavities are at last obliterated. It is not certain that we can account for the hardness by the same physical cause, but it seems most probable, notwithstanding the apparently rapid course which the disease pursues in some cases, that the hardness is not the result of inflammatory action, but of the pressure. Dr. Sims, from whose paper I have quoted a case, considers that there are two kinds of hypertrophy, the one consisting simply of a mere addition of similar particles, the other resulting from a change in texture. I think it very doubtful if they are not one and the same disease. Induration of the brain does take place quite independent of hypertrophy, where there is no pressure to account for it, as will be mentioned further on. It appears that this disease was first distinctly recognized by the celebrated Laennec. It has been asserted that it was known to Morgagni, but I see no reason for this opinion. The only observations of this famous observer which could countenance this idea are in his fourth epistle, in which he treats of serous apoplexy. The existence of this disease was scarcely allowed at all at that time, so that he was obliged to use every argument he could to prove it. In this letter, when endeavoring to account for apoplectic symptoms being produced by a very small effusion, he says, "This must be accounted for from the bulk of the cerebrum or cerebellum being disproportioned to the bulk of the cranium; and as this want of symmetry frequently happens betwixt other parts, why may it not sometimes happen betwixt these also?" He says he was led to this opinion by "observing in some, how very deep a hollow was formed by the vessels that are prominent in the dura mater." He makes no remark which could lead one to believe that he had ever met with a case of true hypertrophy. His observations are so accurate and his perception so acute that he would not have passed it over if he had seen it. The first observations of Laennec occur in some reflections on hydrocephalus, added to a memoir of M. Matthay, of Geneva. He says,* that "there is a third alteration which produces the same effects, the brain being in some instances too large for the skull, as was remarked by Morgagni. M. Jadelot has told me that he has observed the same thing in infants, and has remarked that a great number of those who die of internal hydrocephalus do not show anything else on opening the body besides this disproportion of volume between the brain and cranium. It has also happened that I have seen some patients that I have regarded as attacked with internal hydrocephalus, and who on opening the bodies have presented but a small quantity of water in the ventricles, whilst the convolutions of the brain strongly flattened showed that this viscus had undergone compression, which could only be attributed to too great volume, and consequently to a too active nutrition of the cerebral mass."

* Journal de Medecine de MM. Corvisart, Leroux et Boyer, tom. ii. p. 669. Neur. 1806.

In 1823, he again treats of this disease, having evidently seen several cases in the meantime. The following description, which is in his own words, gives so complete an account of the disease, that it is impossible to add much to it:—" This alteration, comparatively common in infants, is rare in the adult. It is characterized by very great firmness of the cerebral substance, by a considerable widening of the cerebral convolutions of the brain, although the ventricles contain little or no serum. It may be developed slowly, but more frequently it is an acute affection, the symptoms of which are very analogous to those of hydrocephalus. It appears to be the result neither of inflammation nor of the excess of action of this organ, for it is not more common in men of study than in others; and it is rare that inflammation is even occasionally the cause of hypertrophy, unless it be in that of the tonsil glands. In almost all other organs, prolonged frequency or repeated inflammation ends by producing atrophy."

M. Scoutteten was the next who detected any cases of this disease. His observations are published in the 7th volume of the Archives General de Med., Jan. 1825. He gives the case of a child five years and a half old. His head was very large, but his intellect below par; he died after sixteen days' illness; he only entirely lost his consciousness on the day of his death. The *post-mortem* appearances were those of hypertrophy.

M. Dance* in 1828 related four interesting cases of this disease, all occurring in adults from the age of twenty-four to thirty years.

The first case was a young man of twenty-six years of age, who received a blow at the age of fourteen with a hatchet on the vertex of the head, just twelve years before his death; he was not stunned by the blow, but he was attacked with delirium, and remained seven months ill; from this time till about six weeks before his death he suffered but little in his head, except from cold, any exposure to which gave him pain. Previous to his death his principal symptoms were violent paroxysms of pain and a very slow pulse. There was but little disturbance of intellect, or sensation. The appearance of the brain was most striking. —" All the convolutions, particularly at the upper part, had increased to double their normal size, they were flattened, and so jammed one against the other, that it was difficult to perceive the separations between them, so that the surface of the brain presented a plain surface, without elevation or depression. The arachnoid and pia mater were firmly adherent, as was the pia mater to the convolutions, and these membranes seemed thinner than natural; they were not at all injected, and were so glued together that they could not be separated without tearing them. The whole cerebral substance looked much like the white of a hard-boiled egg; its weight and density were considerable, it did not fall to pieces, and resisted under pressure. When drawn out, it elongated considerably, and then resumed its shape, like an elastic body; no trace of vessels, no mottled appearance, nor no red hue, was to be seen; on the contrary, the cortical portion appeared paler, the medullary whiter, than usual. The ventricles contained no fluid; their cavities appeared

* Observations pour servir à l'Histoire de l'Hypertrophie du Cerveau, par la Donce, Rep. Général d'Anat. de Physiol. et du Pathol., p. 197.

but of half their usual size, from the encroachment of their walls. When the cerebral mass was removed, there did not appear to be a drop of fluid in the cranial cavity, the surface of the arachnoid being as dry as parchment; the pons Varolii was slightly in the same state as the brain; but the cerebellum and medulla oblongata presented no abnormal appearances. The other organs were quite healthy."*

In the second case, the subject of it, twenty-four years of age, was slightly imbecile in intellect; he suffered from pain in his head, but not from any convulsions, previous to his admission into the hospital. On the sixth day after his entrance there, he was seized with convulsions, stiffness of the limbs, and grinding of the teeth; after suffering from several such fits, he sunk into a comatose state, and with dilated pupils and stertorous breathing, died.

The *post-mortem* appearances were strikingly similar to the last. The cerebellum was healthy in every respect.

In the third case, the intellect of the patient, who was thirty years of age, had been for some months gradually giving way. A few days previous to death he was found lying on the ground, insensible and paralyzed; he slightly recovered his consciousness, but not to any extent. The *post-mortem* appearances were the same as in the two last cases.

The fourth case is too interesting to abridge.†

Case 98.—"A house-painter, thirty years of age, of an athletic constitution, was taken to the Hôtel Dieu, having epileptiform paroxysms, which recurred three or four times in the day.

"We did not see him till the day after his admission; he spoke with extreme slowness and with remarkable difficulty, which seemed to arise from want of memory, for he sought his answers for some time, and repeated them again and again, as if to assure himself of their exactitude. He did not understand all the questions that were asked him, yet he gave us a history of himself, conformable in many points to that which we had got from his wife. His pulse was full and rather quick; his face red; the skin hot; his respiration was interrupted by involuntary sighs; there was no change in the form of the mouth, nor paralysis of any of the limbs.

"For six years previously he had been subject to determination of blood to the head; at times he was attacked by a giddiness, which lasted from three to four minutes; he then lost the use of his senses and became quite stupefied. But three years since he fell from a third floor, and these fits became changed to true epileptic attacks, recurring at first at long intervals, but afterward following one another more closely, so that at this time he had four or five fits a day. He was habitually of a gloomy, taciturn character; he was of a full habit, and frequently complained of pain in his head and stomach. Blood-letting had always calmed and lessened these attacks; spirituous liquors, in which he sometimes indulged, always augmented his malady. On the 12th of March, three days before his admittance into the hospital, having drank two glasses of punch, he was attacked in the night by very violent convulsions; a physician was called, who prescribed twenty leeches to the epigastrium; but the patient was not benefited by the application.

"At the hospital he was bled, which seemed only to make him worse. During the night of the 16th he had three fits in close succession, of a true epileptic character. On the morning of the 17th he had a distracted air, not answering questions; soon became comatose, with loss of sensation and motion. Eyes closed, pupils contracted, mouth half open, tongue raised, respiration stertorous, profuse perspiration, pulse 140. Sometimes tension and stiffness of the limbs, followed by general collapse, and death at 10 A. M. The *post-mortem* appearances were those of true hypertrophy.

M. Meriadec Laennec was the next who wrote on this subject; but his memoir was written without being aware of the existence of that of M. Dance: he relates five cases, all adults.‡ In all the cases there

* Op. cit., p. 200. † P. 206.

‡ Observ. pour servir l'Historie de l'Hypertrophie du Cerveau: Revue Méd., tom. iv. 1818.

were epileptic fits or epileptiform convulsions. In all, the *post-mortem* appearances were the same; all characteristic of hypertrophy of the brain. In three of the cases, the patients had suffered from lead colic, and were exposed to the influence of lead at the time of their attacks.

In the first case, the patient 32 years of age, the course of the disease was most rapid, the cerebral symptoms only lasting ten days; but the usual *post-mortem* appearances were found.

In the second, the patient, 44 years of age, was ill apparently about one month; the symptoms were those of cerebritis, and the appearances those belonging to hypertrophy; there were hardening and flattening of the convolutions, and absence of blood in the substance.

In the third case, the patient, ætat. 43, had an epileptic fit on the 1st of January; they were repeated at intervals; on the 21st he had several, succeeding each other very closely, and he sank on this day. The *post-mortem* appearances the same as in the others.

In the fourth case, the patient, ætat. 22, had an epileptic attack on the 30th of March, and died on the 2d of April, having had several fits previous to her death.

In the fifth case, the patient, ætat. 13, was a delicate child from birth; weak intellect, but not idiotic; suffered in his head for above a year previous to death.

M. Meriadec Laennec considers that the rapidity of the course of this hypertrophy of the brain allies it more nearly than any other hypertrophy to the inflammatory turgescences.

Dr. Sims published some cases of hypertrophy and atrophy of the brain in the nineteenth volume of the Transactions of the Medico-Chirurgical Society. One of these is interesting, from its affording an instance of very partial hypertrophy. The disease is generally confined to the hemispheres of the cerebrum; but in this case the corpora striata, one thalamus, and the tuber annulare, were alone affected.

Case 99.—C. D., æt. 60, a lunatic for twenty years, with lucid intervals; he was approaching to a state of fatuity; he complained much of great weakness of the lower extremities; he had a carcinomatous disease of the lower lip, which Mr. Perry removed. The wound looked well at the time of his death.

Inspection.—Head.—The skull was remarkably hard; there was serous effusion between the membranes, and a large quantity in the intergyral spaces. On opening the ventricles, the corpora striata appeared pressed much closer to each other than usual. The right corpus striatum was twice its ordinary size; the left slightly enlarged. The left thalamus was very much enlarged. The tuber annulare appeared half as large again as usual; the crura cerebri were also enlarged.

The latest information regarding hypertrophy is from the pen of Dr. Mauthner, of Vienna.* The following account is taken from an admirable review of the work in the British and Foreign Medical Review, vol. xxi. p. 387.

Dr. Mauthner weighed the brain of 216 children, at all ages from birth up to the eighth year, during the whole of which period an increase in its weight is pretty constantly going on.

"During this time," says he, "we find a minimum of 10 oz. 6 dr. rise to a maximum of $44\frac{1}{2}$ oz. The average weight begins with $13\frac{1}{2}$,

* Die Krankheiten des Gehirns und Rückenmarks bei Kindern. Durch Krankheitsfalle aus dem ersten Kinderspitale erläutert, von Dr. L. W. Mauthner. Wien, 1844.

and rises to $35\frac{1}{2}$ oz. During the first year it grows from $13\frac{1}{2}$ to $20\frac{1}{2}$, or 7 oz.; in the second, from $20\frac{1}{2}$ to $25\frac{1}{2}$, or 5 oz.; in the third, from $25\frac{1}{2}$ to 32, or $6\frac{1}{2}$ oz.; and between the fourth and eighth year, from 32 to $35\frac{1}{2}$, or $3\frac{1}{2}$ oz. Hence it appears that the brain grows more rapidly in the first year of life; that in the second and third years its increase is still considerable, but that its growth is slower after the fourth year. In conclusion it may be observed, as a remarkable fact, that the minimum weight usually occurs in cases of atrophy or phthisis; the maximum in pneumonia, scarlet fever, apoplexy, and cerebral tubercle."—P. 162.

He points out the frequent coincidence with enlargements of the thymus gland, of the left ventricle of the heart, and of the liver; facts which lend some support to Münchmeyer's theory of the connection of asthma thymicum with hypertrophy of the brain. He describes an induration of the brain in anatomical characters similar to hypertrophy; but in which the brain is not larger than natural. The skull is smaller, probably the result of excessive activity of the process of ossification; and hence the pressure to which the brain is subjected. In these cases the child is always deficient in intellectual power, and is frequently idiotic, and unable to walk. The head retains its natural size, but the sutures close unusually early, and the parietal and occipital protuberances are unusually prominent.

Such children present none of those indications of rachitis which so often coincide with hypertrophy of the brain; but the lower animal life thrives at the expense of the higher; the skin is firm, and the body fat and ruddy; the muscles and bones strong, the constitution robust, and the appetite craving.

It further appears, from a minute examination of the condition of the brain in these cases, that its weight is, to a great degree, dependent on the quantity of blood which it contains.

"In detailing the symptoms that ordinarily attend hypertrophy of the brain, M. Mauthner distinguishes the passive from the active form of the affection.

"In passive hypertrophy, the cranium early presents a striking deviation from its natural appearance, in the enlargement and globular prominence of the occiput. The parietal protuberances subsequently project, the coronal and sagittal sutures continue open in the ninth or even in the twelfth month, and the fontanelles remain unclosed for a much longer time than natural; the growth of hair is scanty, and the veins of the scalp are much injected. Children in this state sleep much, though they are easily startled; they sweat much about the head; and when in a sitting posture, the head drops forward by its own weight. Attacks of crowing inspiration occur when the child cries, and not unfrequently end in, or are accompanied by, regular convulsions, and the severity and frequency of these seizures are greatest during the period of dentition.

"Digestion is at the same time impaired, and vomiting and diarrhœa are frequent. By degrees the symptoms of pressure on the brain become more evident, or they are suddenly developed, as the result of the supervention of some other disease.

"When hypertrophy of the brain has reached this stage, the skull deviates still more from its natural shape: the forehead sometimes be-

comes prominent and globose like the occiput; and while the skull goes on acquiring an increased curvature, the region of the temples continues flat, and thus contributes to give to the head the appearance of being formed by the union of the segments of four spheres. During this stage of the affection, the preternatural softening and thinning of the cranial bones, corresponding to the prominences of the convolutions, are distinctly perceptible, especially at the occiput. The functions of the brain become now much disturbed; headache, giddiness, impairments of muscular power, and loss of memory, occur; the child grows sullen, peevish, sleepless, whimpers continually, and rolls the head constantly from side to side. At the same time it becomes choked with phlegm, while the skin becomes every day more flabby, the muscles shrink, the bones grow soft, and the muscular power rapidly diminishes.

"Hence these children lie usually on their back, breathing with habitual wheezing, and suffering from constant dyspnœa, with occasional asthmatic seizures, such as have been already described. When in this condition, slight causes suffice to produce a general excitement of the vascular system, and to excite diseased action in other parts, which render still more obvious the influence of the hypertrophy on the nervous system generally. If the child happen to catch a slight cold, attacks of convulsive cough, or of asthma, occur in consequence, or convulsions come on, which terminate life in a few days."—P. 174.

"Such," says the reviewer of M. Mauthner, "is the course usually run by this affection; but its symptoms differ when, as is sometimes the case, the hypertrophy is partial, or when the disease assumes the active form, or that in which the walls of the skull, owing to the energy of the process of ossification, do not expand in proportion to the rapid growth of the brain. Its symptoms then are usually those of active cerebral disease;—the result of compression of the brain, and its consequent congestion."

In the chapter on chronic hydrocephalus, the diagnosis between that disease and hypertrophy of the brain is stated at great length. The chief differences insisted on by M. Mauthner are thus thrown into a table by the reviewer:—

Hypertrophy of the Brain.	*Chronic Hydrocephalus.*
1. The posterior part of the skull first presents an unnatural prominence.	1. The forehead is the first part to present unnatural prominence; the altered direction of the eyes and the very great width of the sutures and fontanelles are likewise characteristic.
2. Children lie horizontally, or throw the head back.	2. Children lie on the belly, with the head lower than the rest of the body, burying the face in the pillow.
3. Face puffy, eyes inexpressive and staring; mouth half open.	3. Countenance withered, having expression of premature old age.
4. Functional disturbance comes on very gradually; not before the period of dentition or weaning; and consists, at first, in affection of the respiratory apparatus, difficulty of breathing, and attacks of apnœa.	4. Functional disturbance occurs early, and involves the cerebrum from the very beginning.
5. Patients fat and leucophlegmatic.	5. Patient ill-nourished, subject to rickets and tabes mesenterica.

Dr. Mauthner* has pointed out a peculiar form of induration of the brain occurring in children who have died of marasmus. It consists of a partial induration of the organ, and though often associated with diminution in the size and weight of the organ, is sometimes met with independent of any alteration of its volume. He regards it as a result of a state of congestion or inflammation; but the symptoms by which it is attended are very obscure, consisting in convulsions, torpor, and very rapid emaciation. The centrum ovale and the walls of the lateral ventricles, especially at the anterior or posterior horn, are its most frequent seats, and it is sometimes remarkably evident when it affects the tænia semicircularis. The indurated portion usually has an elongated form, is distinguishable by the gray color of the cerebral substance, but especially by its cartilaginous hardness. The form of induration of the brain, of which Dr. Mauthner relates three instances, has, to the best of my knowledge, never been noticed by any other writer. It is, therefore, worthy of mention, though, at present, little more than a pathological curiosity.

The treatment of hypertrophy of the brain necessarily differs according to the circumstances under which it occurs. In that form which is connected with rickets, absorbents with rhubarb and preparations of iron, and a properly-regulated diet continued for months, are often very useful. Cold sponging of the surface is frequently of service, but in consequence of the tendency to perspiration about the head, care should be taken not to leave it quite bare; but it should be constantly covered with a light cap. In the other form of the disease, whatever might tend to excite the brain must be avoided, while the long-continued use of the iodide of potassium has been found beneficial. Warm baths and the occasional application of the moxa, and blisters to the back of the neck, have likewise been of service.

* British and Foreign Medical Review, loc. cit., vol. xxi. p. 390.

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COMPARATIVE ANATOMY AND PHYSIOLOGY OF BRAIN.

PATHOLOGY OF THE BRAIN.

THE END.

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